Flock Association
of Europe

WE LIKE TO FLOCK IT

27th INT. FLOCK SYMPOSIUM

16.-17.05.2024, Düsseldorf


2024

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PROGRAM OF LECTURES

LECTURES 1ST DAY

LECTURES 2ND DAY

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FOR THE PLANET

4.0 RANGE

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New Materials and Technologies

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Sustainability and Environmental protection

Eco-friendly flocks

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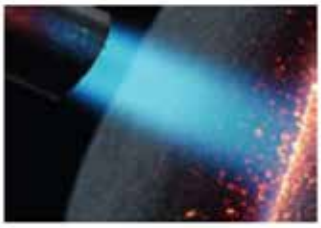
Look for our FSC®-certified products

Recycled


Recycled Polyamide
Recycled Polyester
Recycled & compostable Ground Cotton
Closed-loop Flocks: Collect & recycle

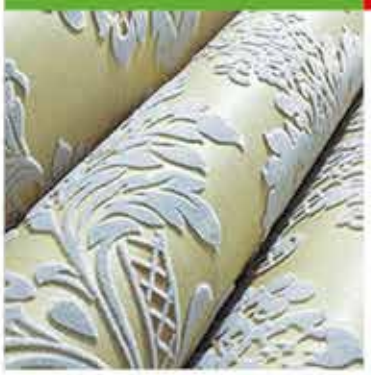
Flocks for protection

Air Cleaning
Bacteriostatic
Flame Retardant
UV Resistant

Functional Flocks


Water repellency
High Transparency
High Water Absorption



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Preamble

Dear Participant,

the board of the Flock Association and I would like to welcome you to our 27th international Flock Symposium, this time in Düsseldorf on the Rhine.

Our association's symposia are among our most important events. They have been taking place since the 1970s. Every two years, experts from the flock industry meet in person to exchange ideas and learn about new developments in our specialist presentations.

Together with you, we will take the opportunity to take a look into the future of our industry, network, experience new things and learn - because "Flock creates connections".

Our speakers are looking forward to informing you about innovations that affect our industry. We have once again deliberately sought out contributions from different areas of the industry in order to present you a varied and interesting programme.

We are delighted that you are attending our event. Take advantage of the opportunity for personal dialogues and to make new contacts. Please do not hesitate to contact me if you have any questions about our Flock Symposium or our Flock Association. On behalf of all Flock Association board members, I wish you a successful, enjoyable Symposium 2024 and networking!

Yours Stephanie Wegner

Stephanie Wegner
Office Manager Flock Association of Europe

The Association

ACHIEVING GOALS TOGETHER

The Flock Association of Europe was founded in 1981 in Büdingen (Germany) and sees itself as the central representing of the interests of all companies involved in flock-technology. The elements of the organisation are the members-assembly and the board. Our members and interested parties are supported in questions related to all aspects of flock, its application and use.

JOIN US...

... to establish FLOCK as a high tech solution in functionality and comfort.
... to establish FLOCK as a premium solution for application.
... to get inspiration from international events.

MEMBERSHIP

We welcome all who are interested in flock, its uses and applications. More information about flock, and our association, along with a membership form, can be found online at www.faoe.eu.

GET IN TOUCH!

1. Fundamentals of odor perception – physiological and psychological aspects

Dr. Michael Holzwarth
HEAD OF COMPETENCE CENTER VIAQ, ODOR (IMAT-UVE GMBH NL STUTTGART)

Michael Holzwarth completed a chemistry degree at the Technical University of Darmstadt and then received his doctorate at the University of Hamburg. He came to imat-uve in 2005, where he quickly became the leading expert in emissions testing and, from 2008, part of the laboratory management.

Between 2015 and 2019 he was the Head of Testing and Validation (laboratory manager) for the emissions test lab in Stuttgart and from 2016 he also had global technical responsibility for odor and emissions testing for the whole imat group. M. Holzwarth has been the Head of Competence Center VIAQ, VOC and Odor since 2019.

As an expert on the VDI/DIN-Commission "Air Pollution Prevention", he is involved in the development of international standards for the investigation of VOC emissions from vehicle interior materials and VOC analyzes of vehicles. As a DIN delegate, he represents the German mirror committee (NA 134-04-04) in working groups for ISO/TC 146/SC 6 "Indoor Air", which develops and revises the standards of the ISO 12219 and 16000 series.

FUNDAMENTALS OF ODOR PERCEPTION – PHYSIOLOGICAL AND PSYCHOLOGICAL ASPECTS

The perception of odorants takes place via the olfactory mucosa (4-5 cm^2) in our nasal cavities. This is where the receptor proteins are located on the cilia (flagella-like cell extensions) of the receptor cells (neurons). In total, each person has between 5 and 50 million receptor cells, each of which only has the receptor proteins of a single type. In humans, there are about 350 different types of these receptors. The signal transduction of a receptor activation by an odorant molecule leads directly into the brainstem via only 2 neurons. This is also where our limbic system, the center of emotions, is located. In all other sensory perceptions, all signal transduction takes place via at least 3 consecutive neurons.

Illustration 1: Cross-section of a human head with visible nasal cavity and the olfactory path with the olfactory bulb (yellow-marked structure in the brain). [1]

Illustration 2: different types of olfactory cells (schematically shown in red, green, and blue) as well as olfactory pathway and synapse on the 2nd neuron in the olfactory bulb. [2]

[1] By Patrick J. Lynch, medical illustrator, CC BY 2.5, https://commons.wikimedia.org/w/index.php?curid=1498092

[2] Press release. NobelPrize.org. Nobel Media AB 2020. Thu. 2 Apr 2020. (https://www.nobelprize.org/prizes/medicine/2004/press-release/)

The sense of smell is thus the most immediate of all human senses. It is also the only sensory perception that is not filtered by the thalamus, the „gateway to consciousness". In this way, it can be understood that we are particularly good at remembering olfactory impressions. Even decades after the last perception, we can identify smells and assign them to the place, the situation, or the emotions during their imprinting. The question of whether we are familiar with the smell or not also has a major influence on the emotional and hedonic connection of an olfactory quality. Familiar smells are typically perceived significantly more pleasantly than unfamiliar and strange ones.

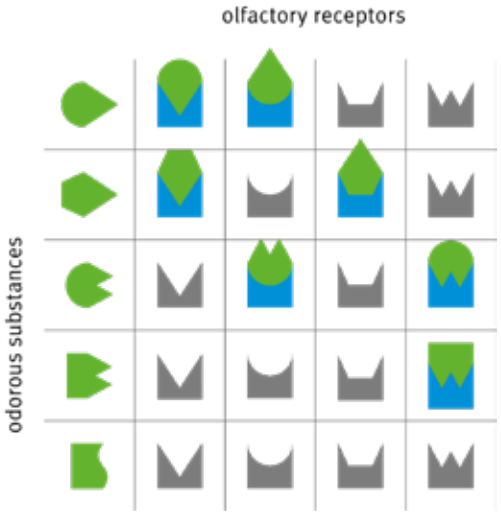


Illustration 3: Schematic representation of the principle of „receptor code" as a combination of the activated receptor types for the expression of an odor quality in each case [3]

With more than a trillion (= 10^{12} or a million times a million), the number of different odor qualities a humans can discriminate, clearly exceeds the number of different receptor types (350, see above).[4] This is possible because each individual odor is expressed by activating a specific combination of the different receptor types. Changes in odor qualities due to variation in odorant concentrations occur because additional receptor types can be activated by higher substance concentrations.

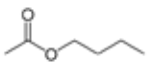
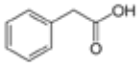
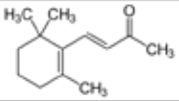
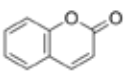
odorant		low concentration	high concentration
	n-Butyl acetate	sweet	(ripe) banana-like
	Indole [5]	flowery	fecal
	Phenylacetic acid [5]	honeycomb-like	urinary
	β-Ionone [5]	viola-like	cedar-like
	Coumarin [5]	woodruff-like	unpleasantly sweet herbaceous

Table 1: Examples of changing odor quality with variation in substance concentration

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[3] Modified from: Joanna Ko´smider - Own work, Public Domain, https://commons.wikimedia.org/w/index.php?curid=15390073

[4] C. Bushdid, M.O. Magnasco, L.B. Vosshall and A. Keller "Humans Can Discriminate More than 1 trillion Olfactory Stimuli", Science, vol. 343 (6177), pp. 1370 – 1372, 2014.

[5] W. Legrum, Riechstoffe, zwischen Gestank und Duft, 2nd ed. Springer Fachmedien Wiesbaden, 2015

As with all senses, the perceived intensity of smell (olfactory strength) is subject to a logarithmic dependence on the stimulus (odorant concentration). The relationship between the odorant concentration and the intensity of perception can be described here by the law of Weber and Fechner. With a constant increase in the odorant concentration, the intensity of odor perception increases more and more slowly. As a result, even if the concentration of an odorant is significantly reduced, the intensity of perception often does not decrease noticeably or only decreases slightly.

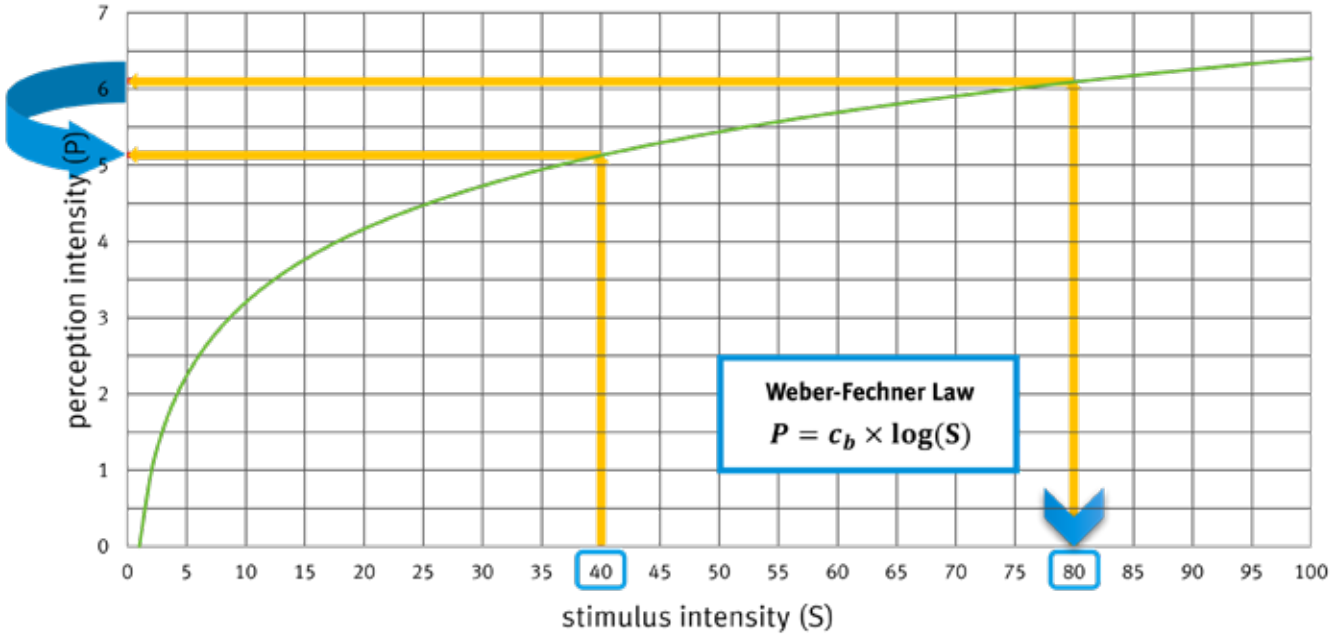

Illustration 4: Weber-Fechner Relationship and Clarification of the Low Success in Halving the Substance Concentration

In the (qualitative) assessment of odors, regional differences are also observed again and again. This is particularly evident for the years between 2015 and 2020 through J.D. Power's annual customer survey in various global markets. While the smell in the vehicle interior does not seem to play a role in surveys on the problems with new vehicles in the U.S.A., a completely different picture emerges for China. Here, „unpleasant smell in the interior" was by far the most frequently mentioned problem.

Rank	Problem Symptons	PP100 (2020)
1	unpleasant interior smell/odor	10.4
2	excessive road noise	7.1
3	excessive fuel consumption	5.1
4	insufficient engine/motor power	3.4
5	abnormal engine/motor noises	3.2
6	air-conditioning does not achieve/maintain desired temperature	3.2
7	fan/bower excessive noise	3.0
8	excessive wind noise with windows/sunroof closed	2.9
9	power plug/USB port charges too slow	2.6
10	front wipers do not clear windshield effectively	2.5

Table 2: Top 10 Problems at Industry Level in Chinese Automotive Market based on customer feedback[6]

6 J.D. Power and Associates 2020 Initial Quality Study (IQS)

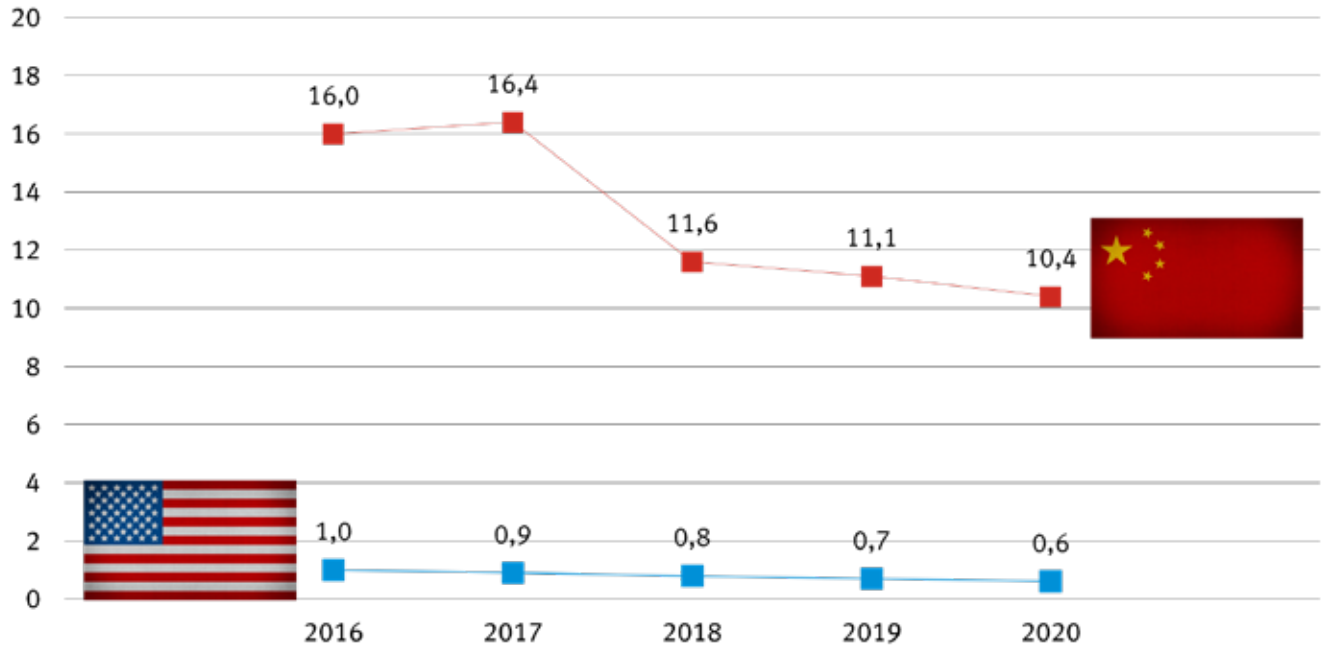

Illustration 5: PP100 value for "unpleasant interior smell/odor" from J.D.Powers annual Initial Quality in China and U.S.A. 2016—2020[6]

In some cases, considerable differences in the perception of specific odors can be traced back to genetic causes. However, the theory of fundamentally different (physiological) sensitivities of geographically definable population groups has been refuted by numerous studies. This means that the Chinese are by no means more sensitive to odors than Europeans or Americans. Genetics is therefore ruled out as the cause of the different evaluation of new car smells. Typical for regionally differing evaluations of the same odor is the (often unconscious) pre-imprint of the odor. One example is the much more positive classification of the aroma of lavender (known in France) in France than in the (French-speaking part of) Canada.[7] Conversely, maple and wintergreen are rated much more positively in Canada (where they have a positive influence) compared to France, where these olfactory qualities are largely foreign, and receive significantly more critical ratings.

The main reason for the negative impact on odors in vehicle interiors in China is likely to be the deeply shaken trust in the regulations and monitoring to ensure product safety. Countless scandals, such as the well-known milk powder scandal in 2008, continue to unsettle the Chinese population. Experience with contaminated and unhealthy food also fuels fears about other products and deep concerns about the effects of unknown odors in vehicles.

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7 C. Ferdenzi, P. Joussain, B. Digard, L. Luneau, J. Djordjevic, and M. Bensafi, "Individual Differences in Verbal and Non-Verbal Affective Responses to Smells: Influence of Odor Label Across Cultures", Chemical Senses, vol. 42, pp. 37-42, 2017.

NOTES

Flock Association of Europe

2. Green Flock: navigating sustainability challenges in the flock industry

Beatrice Casati
CASATI FLOCK SRL

Beatrice Casati holds a Bachelor Degree in Economics and Management at Università Cattolica del Sacro Cuore in Milan and a Master in Entrepreneurship and Innovation at Solvay University in Bruxelles. She is currently the CEO and Sales Director of Casati Flock, the third generation of the family business established in 1952. Committed to the future, she guides the company in producing textile powder from natural and synthetic fibers with a strong emphasis on sustainability and innovation, with a vision of revolutionizing the flock market. This ambitious goal is not just about transforming the industry but also making flock something universally recognized, spreading its potential transcending its current niche status. Her recent academic achievements include a Master Degree in sustainable fashion management and also a standard course in sustainability management, enriching her expertise with her commitment to becoming a sustainability manager within her company to not miss the opportunity to keep Casati Flock aligned with the goals of Agenda 2030.

GREEN FLOCK: NAVIGATING SUSTAINABILITY CHALLENGES IN THE FLOCK INDUSTRY

This lecture explores the transformative impact of sustainability within the flock industry, addressing misconceptions and urging a reevaluation of choices. The lecture sheds light on the industry's challenges in the context of broader textile developments.

Here below we have a quick overview of the topics we will face during this first "green lecture":

- Sustainability, ESG and Agenda 2030: a general overview of what sustainability is and its KPIs and global guidelines
- Flock Essence: examines the common misconception surrounding flock as an unsustainable element and its challenges amidst global climate changes
- Informed Decision-Making: fosters awareness for making informed choices, emphasizing the importance of understanding and reevaluating materials used in flock production
- Ecodesign Principles: embrace the principles of ecodesign and assess material compatibility as crucial factors for sustainable evolution
- Material Exploration: delve into recycled and alternative materials, challenging preconceived notions about their viability compared to traditional options
- Certifications: investigate the significance of certifications as essential benchmarks for ensuring sustainable practices in material management

- Innovative Approaches: engage with the latest developments in sustainable fibers or dyes, and how flock should approach them
- Collective Vision: a collective effort to pave the way for a greener and more sustainable future for the flock industry

The overall goal of this lecture is to raise awareness that the planet is facing major problems such as climate change and resource depletion and that our flock sector is also responsible for all of this and therefore we need to gain more knowledge about it.

This lecture aims to give a general overview of what sustainability is, what indicators are used to measure it, what is currently being asked at a global level by the 2030 agenda and starting from this general topic, to come up with the first concepts and reflections on how this topic is impacting and will impact the flock world. We need to be aware that the world of flock deals with many critical issues related to sustainability in general, for example:

- textile raw materials and their environmental impact
- chemical products used in the raw materials themselves and in the manufacturing processes both during flock production but also in flocking
- the flocking technique with the related problems during the application phase
- recyclability of flocked products

There are many other topics that concern sustainability issues of our sector, but as already mentioned, this lecture aims to be a starting point to give an overall vision and a beginning to subsequently set up a road map of how to improve the various critical points.

So, it's up to us to figure out how to make things better.

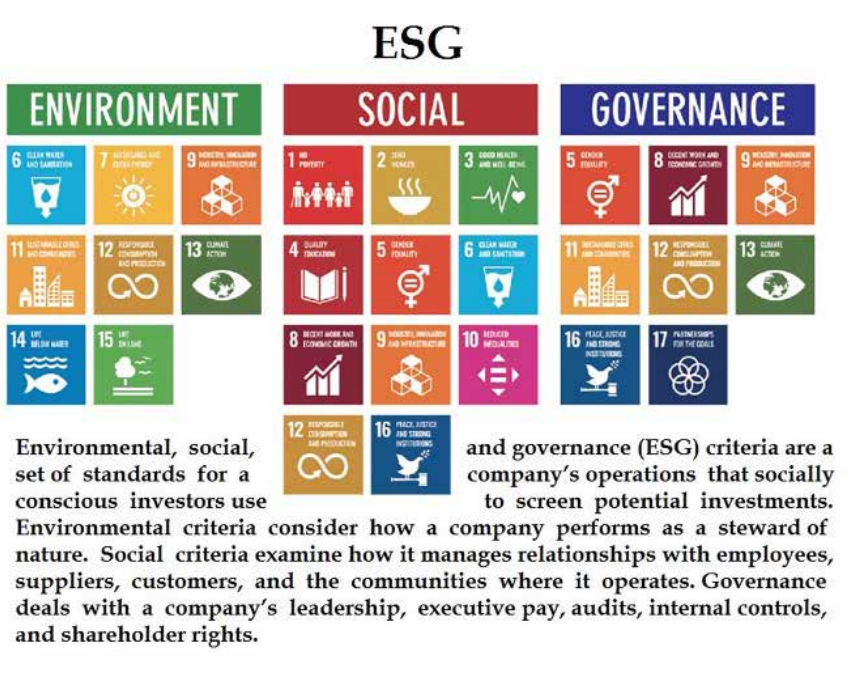
WHAT IS SUSTAINABILITY?

"If you really think the economy is more important than the environment, try holding your breath whilst you count your money."
Dr Guy McPherson

First off, let's talk about what sustainability means. It's about finding ways to use resources wisely so that we don't harm the environment or future generations. We want to balance making money with taking care of the planet and treating people fairly.

HOW ESG DRIVES THE 2030 AGENDA

The ESG (Environment, Social and Governance) criteria and the Sustainable Development Goals (SDGs) of the 2030 Agenda are two essential levers for evaluating and promoting sustainability in different sectors.



The Sustainable Development Goals (SDGs) represent a set of 17 global goals adopted by the United Nations in 2015 as part of the 2030 Agenda, approved during the United Nations Summit on Sustainable Development, which was held from 25 to 27 September 2015, in New York. During this summit, world leaders formally adopted the 2030 Agenda for Sustainable Development, which includes 17 Sustainable Development Goals (SDGs) and 169 specific objectives. These goals cover a wide range of issues, including poverty, hunger, health, education, gender equality, clean water, sustainable energy, biodiversity, decent work, innovation industry and climate action.

ESG criteria, which concern environmental, social and governance aspects, are the three pillars used by investors and organizations to evaluate the sustainable performance and social responsibility of companies.

In summary, ESG and SDGs are complementary tools used to evaluate and promote sustainability. The SDGs provide global guidance to address broader sustainability challenges, while the ESGs offer specific criteria for evaluating corporate environmental, social and governance performance.

FLOCK IS ONLY SYINTHETIC AND IS NOT SUSTAINABLE: A BIG MISCONCEPTION

The first big problem is that few people outside our sector know what flock is, those few who know it often only associate it with synthetic fibers and therefore reflexively think that it is all unsustainable. Imagine, starting from such a base of little knowledge, how difficult it can be to connect the flock to sustainability. But there is this possibility: to educate and make known.

Now, when it comes to the flock industry, we have some challenges concerning sustainability. For a long time, people thought flock wasn't very good for the environment. Of course on one side we have critical aspects, but on the other one we still have big opportunities to do things better and offer more environmentally friendly products and services.

One big idea is to use different materials that are better for the planet. Instead of always using new stuff, we can recycle things like textile or plastic materials or use natural materials like linen or hemp. These changes can

help us make flock in a way which is kinder to the Earth.

ECODESIGN – FLOCK CON BE ECODESIGNED?

But it's not just about what we use; it's also about how we make things. We can design products to last longer and to be easily recycled. Moreover, we can find ways to reuse materials instead of throwing them away.

What is Ecodesign? Ecodesign involves designing or redesigning products, services, processes or systems to avoid or repair damage to the environment, society and the economy. Ecodesign is present all around us - in sustainable flooring, green energy heating systems, eco-friendly packaging and even recyclable products. The main goal of eco design is to anticipate and minimize negative environmental impacts.

Certainly an important aspect is to question ecodesign and the compatibility of materials. A simple example is packaging or fabric: beyond the visual or tactile aspect or the technical characteristics of a synthetic flock compared to a natural flock, let's think of a flocked packaging or any flocked base. If the base is made of cellulose and therefore paper, we should ask ourselves whether applying a nylon flock is the best choice for the end of life of that packaging.

TRANSPARENCY AND COLLABORATION

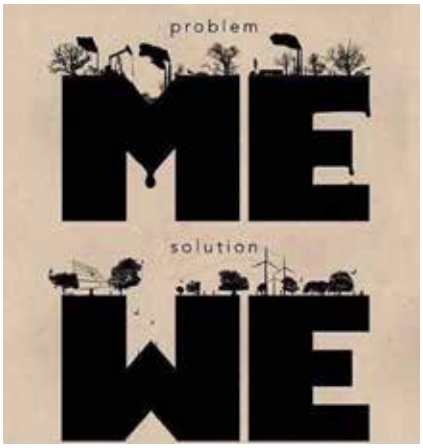
It's also important to be honest about how we make flock. We should tell people where we get our materials from and make sure workers are treated fairly. Being open about these things helps build trust with customers and makes sure everyone is doing their part to protect the planet.

IMPROVEMENTS - A FIRST STEP

Now, let's talk about where we need to improve. Sometimes, making flock can use too many chemicals or water and also raw material that have an impact too. And we can create a lot of waste too that ends up in landfills. We need to find ways to fix these problems.

As a group, we can take some steps to make things better:
1. Research better ways to make flock that are kinder to the planet.
2. Teach people in the industry about eco-friendly practices.
3. Ask lawmakers to make rules that help the environment.
4. Work together and share ideas to make progress faster.
5. Reward companies that are doing a great job at making eco-friendly flock.

In the end, making the flock industry more sustainable is something we all need to work on together. Let's not just talk about it; let's take action and make a real difference.



NOTES

Flock Association of Europe

3. Hot-melt adhesive for flocking process, new development and new challenges, the way towards sustainability

Alberto Sadun
AIGLE MACCHINE SRL

Alberto Sadun was born on 1966 has studied Economics at Florence University, worked for a short while in England. Since 1995 he've joined Aigle. Now is share-holder and Managing Director. Main actual tasks are sales & marketing and development of innovative projects. Aigle is one of the leading companies manufacturing flocking and coating plants. Flocking belongs to Aigle history since the beginning of the company.

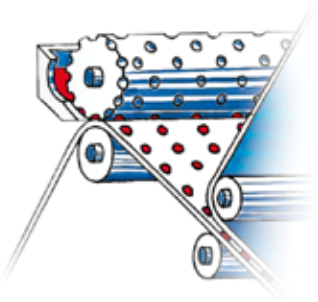
HOT MELT ADHESIVE FOR THE FLOCKING PROCESS

The below will present the outcome of recent tests conducted with the collaboration of an adhesive producer Novotex. Using the Neoflex advanced adhesives (which belongs to Novotex Group), Aigle did new tests of flocking processes with very interesting results.

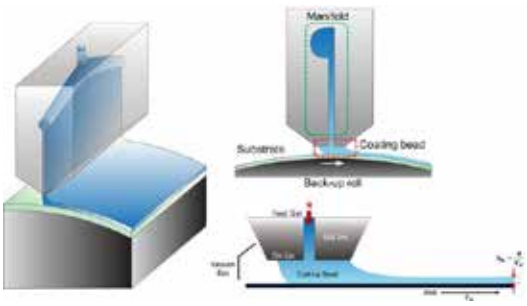
- **Brief introduction on PUR hot melt adhesives**

  PUR Hotmelt reactive adhesives are Polyurethane adhesives formulated with internal crosslinker blocked in the absence of humidity, vacuum and the presence of nitrogen. In the industrial applications the adhesive is freed from the wrapping and pressed with a hot platform completely adherent to the drum's internal wall, it is then fed into heated tubes up to the nozzles and containment tanks and then applied with dots applications by engraved cylinders (Rotogravure) (see pict #1), or full coating by Slot Dye application (see pict #2).

  Reticulation action is developed by temperature, air and humidity. Once applied these adhesives reticulated them selves with air humidity and after about 48 hours (based on the environmental conditions and air humidity) they form a permanent and irreversible bond to the substrate and to the fibres. This guarantees the non-reactivation of the ad hesive ensuring resistance to high temperatures, hydrolysis action and washings, without delamination on the coated substrate.



Pic #1



Pic #2

- **History of hotmelt adhesive test and application for flocking processes**

In 2007 during the 19th Int. Flock Symposium Mr. Arne Voigt, associate researcher at Institute of Textile and Clothing Technology of TU Dresden presented an interesting study on "The use of hot melt for flocking automotive parts with the target to have all components of the same polymer".

The study arrived to the result that "flocking is technically feasible with hot melt adhesives. The surface quality achieved is very good and is characterized by a high flock density and good abrasion resistance. So, basically, the theoretical part of the research was mostly done. However, after considering the possibility to use this kind of adhesive into the flock process we can underline two new interesting aspects:

- After 2007 we've never met an industrial flocking application with hot melt adhesives this, of course, it doesn't mean that no flocker is using hotmelt adhesive but, as flocking line manufacturers, we have not seen this kind of application in operation.
- The second part of the conclusions of the 2007 study states: "Based on further modifications of the process and subsequent developments, the quantity of hot melt adhesive, energy requirement and requisite processing time must be reduced". This is an important aspect of the hot melt application system which will be part of the following analysis.

- **The new recent test in cooperation with Novotex.**

Since years Aigle is producing hot melt applicators for coating and lamination lines and we've been in contact to Novotex and we offered them to cooperate on new tests of hotmelt application using their adhesives.

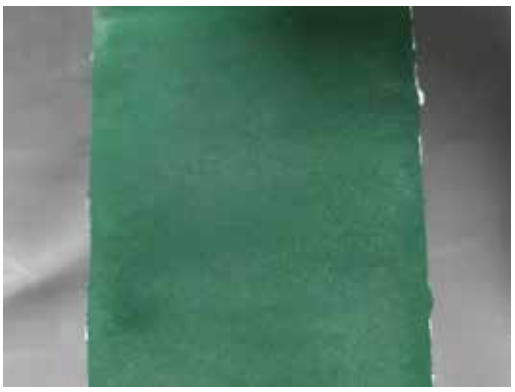
At Novotex laboratory premises we conducted several tests. Novotex suggested us to use NEOTHERM PU-3550.1 adhesive and we've tested it with different supports keeping as low as possible the application temperature (we've never overcome 120°).

We tested this adhesive with different kind of supports:

- PU Foam (see pic #3)
- Transfer paper (see pic #4)
- Pvc (see pic #5)

Pic #3

Pic #4



Pic #5

We've obtained by the application a dry weight between 40 and 60 gr/sqm. On Transfer paper and pvc we've directly coated the support; coating the PU foam we've applied the adhesive film by transfer technology, first we've applied the adhesive film onto the release paper then we've transferred it onto the foam.

At Novotex for coating the adhesive we've used a Film Applicator that foresees a hot plate where the substrate is placed; the principle of adhesive application is based on a heated substrate and a Melting gun that extrudes a string, both at a pre-set temperature (see pict #6). Interesting point for future possible industrial processes is the application technology. We think that the use of a high precision calibrated slot could be the optimal solution for reaching the uniform and constant film necessary for the good result of the flocking process (see pic #7).

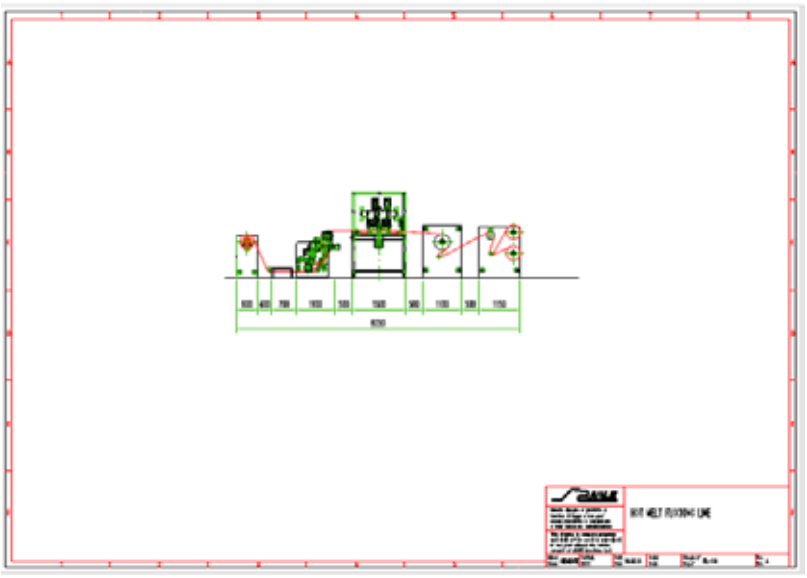
Pic #6

Pic #7

- **Results of the tests**

  We obtained very good results with all the supports tested. At the moment when this paper is written, the flocked supports are in test phases. During the Symposium we'll present the results of obtained performance tests. We've been impressed by the soft touch of the flocked film split by the release paper, and in general by the good density and solidity of the flocked surface.

- **Strengths of the hotmelt adhesive within flocking process:**



  Shorter flocking line & Sustainability (no oven needed) Effectively a flocking line with hotmelt application is much shorter and less energy consuming than a conventional one. (see pict.#8). The absence of the oven, can have a high impact on the energy consumption reduction trend that actually is a goal of many industry sectors. Another important issue for a better sustainability of the flock process will be reached when we will prove that Flock fibres embedded in hotmelt adhesive can create stronger bonds between materials: this might result in having products with longer lifespans. Longer-lasting products reduce the frequency of disposal and the demand for raw materials, thereby promoting a more sustainable lifecycle.

  Good performances

  Same as the conclusion of the lecture of Mr. Voight in 2007 the surface quality achieved is very good and is it characterised by a high flock density and good abrasion resistance (to be still proven for the tests performed in Novotex).

  Better recyclability

  This is very interesting nowadays especially within the automotive sector. Hotmelt adhesives often leave minimal residue compared to other types of adhesives. This reduces the likelihood of contamination during recycling and can lead to higher quality recycled materials.

- **Weaknesses of the hotmelt adhesive within the flocking process**

  Range of Applicability in flocking processes

  At the moment we know that hotmelt adhesives are applicable only on flat surface or slightly curvy surfaces but not on 3D objects.

Hot application temperatures

120° C might not be suitable for all substrates

Cost of the hotmelt adhesives

PUR prices are still higher compared to common industrial adhesives currently applied.

Research

We still need more extensive research in order to achieve the point in which hotmelt adhesive will be considered a valid and reliable alternative to water and solvent based adhesives.

- **Conclusions:**

  The studies have demonstrated that hotmelt adhesive could become in a near future at least a possible alternative as an adhesive with correct characteristics for good performances in the use of flocking process. Aigle - with the suitable equipment- and Novotex - with PUR adhesives - are ready to take on the future challenge.

NOTES

Flock Association of Europe

4. Requirements and concepts for the safe operation of flocking equipment from the user's perspective

DIPL. ING. (FH) ULRICH BÜTTEL
BUE-ENGINEERING

Ulrich Büttel studied mechanical engineering at Reutlingen University. After working as a freelance design engineer for several years, he and a partner founded an engineering company, Büttel und Marx GmbH, which specializes in the development and manufacture of automated special machines.

At the end of 1998, Mr. Büttel took over shares in Maag Flockmaschinen GmbH, which he managed as managing director from 2000 to 2020. Since the end of 2020, Mr. Büttel has been working as a freelance engineering service provider and consultant for the flocking technology, machine safety and explosion protection. Mr. Büttel is an active member of the German Committee DKE K 239 for the standardization of electrostatic spraying equipment.

FOREWORD

Detail of a flocked doormat

In flocking, fibers cut to the same length are applied vertically to a surface coated with adhesive by using the electric field. Once the adhesive has dried and any loose flock has been removed, the flocked surface can be used.

The origins of ‚flocking' lie in the Middle Ages. At that time, paper was coated with resin and sprinkled with fibers for use as wallpaper. The first electrostatic ‚flocking' was used in the 1950s to produce sandpaper. The hard material splinters are shot into the adhesive in an aligned manner due to the high voltage.

Flock fibers can be produced from a variety of materials. Depending on the material, very different mechanical or physical effects can be created in addition to an attractive look and feel.

Flock can insulate, reduce noise, or conduct electricity. Increasing the surface area through flocking can act as a catalyst or filter. The list of possibilities is long. The original purpose of creating a decorative surface has long been extended by a variety of technical applications - and new applications are being added every day...

Flocking itself is a very easy process to handle. Certain risks in handling the necessary materials and machines are described below and solutions for safe operation are presented.

1. Work steps for flocking and possible risks

With direct flocking, the flock surface is created by applying adhesive and flock directly to the workpiece. The application can be applied over a large area or partially.

1.1. Pre-treatment

Surfaces to be flocked must be stable, clean, and free of grease and release agents so that the adhesive layer and flock layer applied later are optimally bonded to the substrate.

The usual pre-treatment methods are:

- Cleaning with a suitable solvent
- Mechanical roughening
- Application of primer
- Flame treatment, corona treatment, plasma treatment
- Fluorination

Possible risks arise from the use of solvents, corrosive substances, or dusts:

1.2. Adhesive application

The adhesive is the link between the substrate and the flock layer. It not only holds the fibers but must itself be adapted to the final use.

The adhesive should be applied in as uniform a layer thickness as possible. A guideline value is a layer thickness of the dried adhesive of 10 % of the flock fiber length. This ensures that the fibers are optimally and firmly anchored in the adhesive.

The adhesive can be applied either over the entire surface or partially, by hand or automatically. Common application methods for adhesive are e.g:

- Brush application (or molded sponge)
- Spraying (with flow cup, pressure container, pump or airless)
- Rolling with a paint roller

- Squeegee in screen printing
- Dipping

Possible risks arise from solvents or adhesive aerosols:

1.3. Flocking

Flocking can be either electrostatic or electrostatic-pneumatic, depending on the workpiece geometry to be flocked. This can be done either with a hand-held device or with a pass-through system.

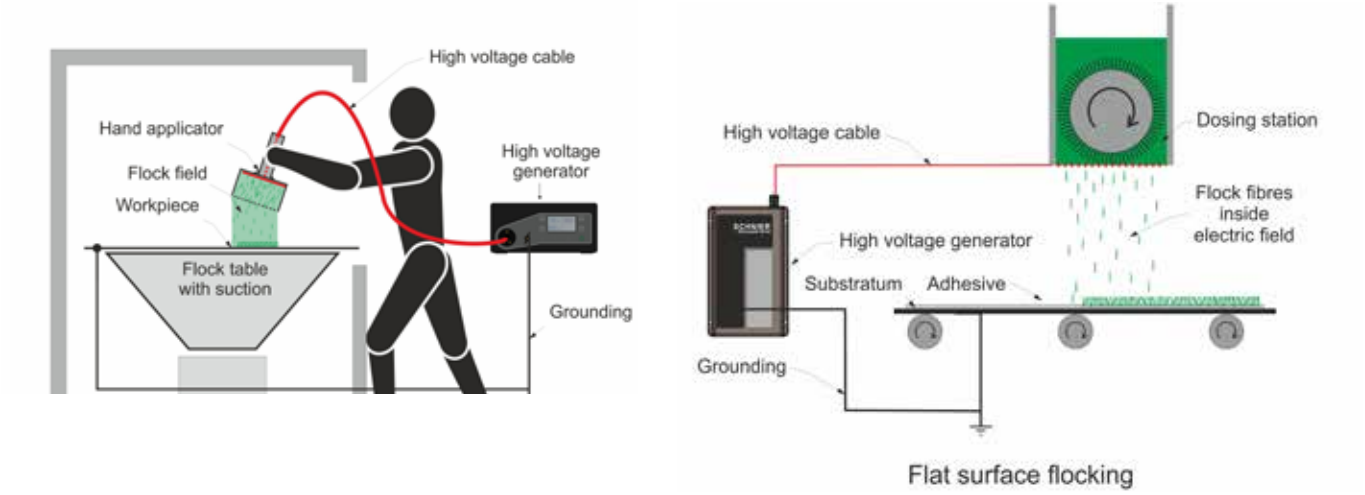


Figure Electrostatic flocking manual and automatic

For flocking, a high-voltage source is usually used to align the flock fibers and inject them into the adhesive layer of the workpiece at an accelerated rate. The necessary voltage can trigger a dangerous electric shock on contact and ignite clouds of flock and solvent as a possible ignition source.

Possible risks arise from solvents, flock, or high voltage:

1.4. Pre-cleaning

After flocking, the workpiece is pre-cleaned of adhering loose flock. This is done by carefully tapping or blowing off with reduced compressed air in conjunction with a permanently vacuumed workplace. The purpose of pre-cleaning is to minimize flock carry-over to other, downstream areas.

Possible risks arise from solvents and flying flock:

1.5. Drying

In the simplest case, the adhesive is dried in the hall air. For higher quantities or higher resistance requirements, drying can also take place in a cabinet dryer or in a continuous dryer.

Drying can be carried out using the following methods:

- Hot air with continuous air circulation
- Infrared radiation
- Vacuum drying

Each drying process has advantages and disadvantages that must be weighed up in each individual case.

Possible risks arise from evaporating solvents and loose flock:

1.6. Final-Cleaning

After drying, the workpiece is thoroughly cleaned to remove any excess flock and is then ready for use.

The usual cleaning methods are:

- Blowing off with compressed air
- Suction
- Ultrasonic cleaning
- Washing

... or a combination of all these methods.

Possible risks arise from loose, flying flock:

2. Materials and possible hazards

Substrate, adhesive and flock must be coordinated as a system to achieve optimum quality of the flocked surface. In some cases, substances must be used that can only be processed in compliance with the necessary safety measures.

It is usefull to check possible alternatives for the materials and application types in advance and, if necessary, to replace them with lower-risk variants.

2.1. Chemistry for pre-treatment

For pre-treatment, solvents are often used to clean the workpieces or primers that contain solvents or other hazardous substances. In principle, the same risks apply as for adhesives.

2.2. Flock

Flock is available in different materials, fiber thicknesses, cut lengths, and finishes.

Common flock materials are:

- Synthetic fibers made of polyamide, polyester (for automotive parts and profiles)
- Organic fibers made of artificial silk, cotton (for textile applications and household)
- Special fibers made of Kevlar, carbon (for higher temperatures and heavy abrasion)
- Exotic fibers made of glass, stainless steel, graphite, etc... (for only technical applications)

The fiber thickness, i.e. the titer, is given in dtex (Dezitex) and describes the weight of a single fiber of 10,000 m length in grams. The designation 6.7 dtex therefore stands for the weight of 6.7 grams for a fiber of 1o km in length. The lower this value, the finer the fiber tends to be. Common titers are between 0.9 and 44 dtex.

Common cut lengths of flock fibers are between 0.3 and 4 mm, depending on the titer.

Most flock types are considered problem-free in terms of processing and material. However, there are exceptions that require more attention during processing and handling:

- Organic fibers made of artificial silk or cotton are flammable and have a low minimum ignition energy. This means that there is a risk of embers and explosive flock-air mixtures in the event of malfunctions.
- This risk is increased if the flock has been processed as ground flock and contains a certain amount of ground dust.

Possible risks arise from flock made from organic material:

2.3. Adhesive

Adhesive manufacturers offer different adhesive systems to suit different materials.

A basic distinction is made between the following main types of adhesives:

- Water-based dispersion adhesives
- Solvent-based adhesives
- Plastisol (single-substance system without volatile components)
- UV-curing adhesives

Most of the adhesive types are considered to be problem-free in terms of processing and material. However, there are exceptions that require increased attention during processing and handling:

- Solvent-based adhesives and cleaning agents, which can form an explosive mixture with air, especially when sprayed.
- Aerosols from water-based adhesives that are sprayed are respirable and may only be processed with effective ventilation or filter protection.

Possible risks arise from solvents and adhesive aerosols:

3. Manufacturer obligations - employer obligations

For manufacturers and operators (employers), the regulations require them to identify potential risks and minimize possible negative effects for people and the environment.

All machines, equipment, stationary or mobile devices that are intended for processing (flammable) materials and have their own potential ignition source and can therefore trigger an explosion are covered by Directive 2014/34/EU (ATEX Directive).

According to the German Ordinance on Industrial Safety and Health (BetrSichV), stationary flocking systems are therefore considered systems that require monitoring and must be checked for safe condition at specified intervals.

3.1. Manufacturer obligations

The manufacturer's obligations arise from the Product Safety Act (ProdSG), converted by EU standards.

The manufacturer is responsible for the safe design of a machine or system so that the safety and health of persons is not endangered when it is used as intended (ProdSG, Section 2, §3).

„Manufacturer is any natural or legal person who manufactures a product or has a product developed or manufactured and markets this product under their own name or brand. A manufacturer is also anyone who attaches his name, trademark or other distinctive sign to a product on a commercial basis, thereby impersonating the manufacturer, or remanufactures a product or influences the safety characteristics of a consumer product and subsequently makes it available on the market." (ProdSG, Section 1, §2, Para.14)

The objective is to achieve EU-wide marketing of equivalent safe products through EU standards.

3.2. Employer obligations

The employer is responsible for the safe operation of machinery and equipment.

Employer obligations arise from the Ordinance on Industrial Safety and Health (BetrSichV), the Occupational Health and Safety Act (ArbSchG) and the Ordinance on Hazardous Substances (GefStoffV).

The requirements of these regulations are implemented in Germany via the Technical Rules for Operational Safety (TRBS) and the Technical Rules for Hazardous Substances (TRGS).

The objektive is to achieve occupational health and safety for employees through safe operation.

3.3. Case study - Procurement of a flocking machine

A fictitious project sequence is used to describe how the requirements from the regulations can be implemented.

A new flocking system is required for a new project:

- A specification sheet is drawn up (or not)
- Offers are obtained, compared and negotiated
- The order is placed
- The equipment is delivered, installed and accepted
- The technical documentation is handed over
- Operating instructions are drawn up, personnel are trained
- The equipment is handed over to production...
- .... and flocked in perfect quality and generates a profit

Now the individual steps in detail:

Normally, the operator should summarize all relevant requirements resulting from the materials used, the planned method of operation and the general conditions in a specification sheet prior to procurement. There is no obligation to do so. It is also helpful to refer to the design in accordance with a DIN-EN standard to avoid later discussions about design details.

In the case of procurement outside the EU, it is not necessarily to be expected that the requirements of EN standards are fulfilled and that this is confirmed by a declaration of conformity. In this example, we assume a manufacturer within the EU.

The manufacturer then delivers the ordered machine to the subsequent operator and provides the contractually agreed services. These are usually:

- Instruction of the operator in the machine functions
- Preparation of the acceptance report and, if necessary, test certificates
- Handover of the operating instructions in the local language
- Handover of the declaration of conformity

This fulfills the manufacturer's obligations.

Before the equipment is handed over to production for the first time, the operator (i.e. the employer) must have dealt with the following issues:

- Preparation of a risk analysis of the overall process
- Preparation of an explosion protection document
- Inspection of the entire system before initial commissioning
- Information signs are visibly displayed
- Operating instructions are drawn up and visibly displayed
- Employees are trained in the overall process

This concludes the project. But be careful:

The employer retains the obligation to continuously review safety-related issues:

- Maintenance and servicing work is carried out according to schedule
- Electrical devices are tested in accordance with the requirements of the DGUV with regard to electrical safety
- Recurring inspections in accordance with BetrSichV Annex 2, Section 3, Numbers 4 and 5 are carried out
- Annual safety training of employees is carried out
- Review and update of operating instructions

4. Regulations for manufacturers

The manufacturer is responsible for the safe design of a machine or system so that the safety and health of persons is not endangered during intended use (ProdSG, Section 2, §3).

4.1. Directives and standards

The following is a selection of current directives and standards that are relevant for adhesive application and flocking:

- Machinery Regulation VO 2023/1230, replaces Machinery Directive 2006/42/EC
- ATEX Product Directive 2014/34/EU (valid since 20.04.2016)
- DIN EN 1953:2021-02 „Application equipment for paints and coatings - Safety requirements“

- DIN EN 16985:2019-04 „Spray booths for organic coating materials - Safety requirements"
- DIN EN 50050-3:2014-03 Manual spray equipment for flammable flock
- DIN EN 50223:2015-09 Stationary electrostatic coating equipment for flammable flock - Safety requirements; this standard contains requirements for flock booths
- DIN EN 1539 - Dryers and ovens in which flammable substances are released - Safety requirements

5. Regulations for employers

The operator (employer) is obliged by the regulations to identify possible risks in the operation of the machine or system and to minimize possible negative effects for people and the environment.

According to the German Ordinance on Industrial Safety and Health (BetrSichV), stationary flocking systems are considered systems that require monitoring and must be checked for safe condition at specified intervals.

5.1. Directive 1999/92/EC and implementation

Directive 1999/92/EC, Directive on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (valid since 20.1.2000).

The member states can go beyond these minimum requirements.

As a result, national implementation varies from one member state to another.

5.2. Ordinance on Industrial Safety and Health (BetrSichV) and Technical Rules

Directive 1999/92/EC was converted into national law in Germany by the Ordinance on Industrial Safety and Health (BetrSichV) and the Ordinance on Hazardous Substances (GefStoffV). These ordinances are very general and are usually of no help in practice.

The driving force behind the regulations in Germany is the German Social Accident Insurance (DGUV). The Technical Rules on Hazardous Substances (TRGS) and Operational Safety (TRBS) offer more specific help in implementing these requirements.

The requirements are described very specifically in the information provided by the German Berufsgenossenschaft (BG). For almost every topic there is a DGUV rule or DGUV information with references to the relevant TRGS / TRBS in the appendix.

5.3. DGUV rules and DGUV Information

A small selection:

- DGUV Information 209-052 Electrostatic coating (BGI 764)
- DGUV Information 209-046 Painting rooms and equipment (BGI 740)
- DGUV Information 209-014 Painting and coating
- DGUV Information 209-087 Fire protection

6. Practice for the employer

In comparison to the manufacturer, the employer is required to ensure that all equipment is kept in a safe condition over the period of use and the associated processes.

6.1. The TOP principle

The TOP principle applies to the prevention and minimization of hazards in the workplace. This describes the priority of measures (technical-organizational-personal).

First, TECHNICAL solutions must be found that work as automatically as possible and prevent operating errors.

ORGANIZATIONAL solutions can be found as a secondary priority, but these do not exclude the risk of (wrong) personal implementation.

The final solution is always PERSONAL protective equipment. In some cases, this solution cannot be avoided. Here too, there is a risk that the measures will only be accepted to a limited extent in practice.

6.2. State of the art and inventory protection

There is no Inventory protection for old or used systems! There is also no obligation on the part of the employer to permanently upgrade old systems to the state of the art.

The operator's obligation is limited to keeping the equipment in a safe condition. The recommendation on operational safety EmpfBS 1114 ‚Adaptation to the state of the art in the use of work equipment' describes the required procedure.

If there is any doubt about the safety level of an old system, it must be retrofitted to ensure safe operation (in accordance with current regulations).

6.3. Modification or retrofit of machinery

According to the new Machinery Regulation 2023/1230, which replaces the Machinery Directive, the term for a substantial modification to a machine is defined in more detail. Anyone who significantly modifies a machine is the manufacturer of the modified machine and must declare the conformity of the modified machine and issue the CE marking.

A declaration of conformity cannot be adapted and extended.

This means that an operator who makes significant changes to an existing used machine becomes the manufacturer - with all the associated obligations.

Conclusion: If a significant change is to be made to a machine, it is helpful to clarify in advance who the, manufacturer' is in terms of the above-mentioned obligation.

6.4. Recurring inspections

In accordance with BetrSichV Annex 2, Section 3, systems subject to mandatory monitoring must be inspected at regular intervals to ensure that they are in a safe operating condition.

Inspections in accordance with BetrSichV Annex 2, Section 3, Numbers 5.2 and 5.3 can be included in the maintenance concept and carried out independently:

- Annually - Ventilation systems and gas warning and inerting devices that are directly used for explosion protection
- 3-yearly - Equipment and protective devices directly used for explosion protection

Inspections in accordance with BetrSichV Annex 2, Section 3, Numbers 4.1 and 5.1 must also be carried out every 6 years by a ‚person authorized to inspect'.

- Completeness and plausibility of the technical documents required for the inspection
- Completeness of the records of the annual and 3-yearly inspections
- Guarantee of safe operation of the system in accordance with BetrSichV
- Effectiveness of the technical and organizational measures for explosion protection

- Effectiveness of an alternative maintenance concept, if applicable

6.5. Important basic documents

Checklist of the most important documents to demonstrate safe operation:

- Risk assessment for the relevant processes and work areas with designation of possible hazards (from DIN EN 12100) and necessary measures for safe handling of machines and materials
- Explosion protection document (DGUV Information 213-106) for explosion hazards
- Operating instructions for the relevant processes
- Labeling of areas with hazards
- Proof that the prescribed initial and recurring inspections have been carried out
- Proof of annual (safety) training of employees

In the event of damage to property or personal injury, these documents are important to minimize possible consequential financial losses (failure of insurance benefits) or claims for damages from employees (due to possible injuries).

NOTES

Flock Association of Europe

5. Car rubber profiles: new development in flocking automation

Andrea Levi
AIGLE MACCHINE SRL

Mr. Andrea Levi studied Business Administration at Università degli Studi di Torino. After two years working at NST srl (flock printing Company) and after ten years as CEO support at AIGLE spa (equipment manufacturer for coating, flocking, lamination and coagulation), he becomes from 2003 shareholder and CEO of AIGLE Macchine srl (information available on www.aigle.it). He is responsible for implementing existing plans and policies, improving the company's strength, supporting ongoing business transformation and setting future strategy.

Mr. Levi is also adviser at LDS spa (artificial leather manufacturer: coating, flocking, coagulation and finishing), Aigle Immobiliare srl and Immobiliare Silvania srl (both real estate companies). Mr. Levi is an active member of the board of Flock Association of Europe.

INTRODUCTION

Flock techniques have been used on rubber, plastic, metal, etc. materials for industries such as automotive, packaging and other commercial fields.

Among the various flocking machines on the markets are lines for flocking automotive rubber components. Over the years, these machines have benefited from progressive technical and technological evolution.

From the positive results of this development, the need to operate flocking lines automatically and with systems to manage the data collected by the electronic instrumentation used on the lines is becoming more and more important.

Flocking lines for automotive profiles is one area where interesting developments were possible. In short, this new development involves dedicated flocking lines for corners of extruded rubber profiles (EPDM, TPE and TPV) previously jointed by special injection moulding machines.

Thus, automated flocking lines equipped with robotized systems together with dedicated automation devices and sensors have been engineered in order to achieve:

- increase of productivity thanks to automation useful to reduce defects and maximise the control of the parameters of the various technical functions used in the plants;
- ergonomics to improve operators' working conditions. In particular, a special profile positioning system was developed to improve the loading and unloading of parts in the line: a hightech lifting system the profile supports in order to make loading/unloading easier;
- higher productivity with less operators involved in the process;
- versatility to quickly change the profile type;
- possibility of collecting process data through appropriate sensors and the use of advanced communication systems to use and process the collected parameters remotely.

These new characteristics allow the use of innovative products with particular reference to automation and process data management applied mainly (but not only) to the automotive sector, which is also one of the fastest growing markets globally (in addition to the automotive sector, the other sectors of applicability are, for example, the aeronautical, naval, railway and construction sectors).

THE STATE OF THE ART AND DEVELOPMENTS

In the area of flocking rubber profiles in recovery, there are applications that require semi-industrial, if not in some cases still artisanal, processes. Aigle itself has developed and installed several flocking lines of this type over the decades. However, these are plants on which it is now considered possible and useful to install robotic systems to automate various stages and above all to manage the process data collection in an appropriate manner.

Furthermore, as far as production automation is concerned, nowadays the pre-treatment part of the profiles and the glue application part are, in most cases, still carried out manually and sometimes off-line.

These experiences led to the need to develop new automated flocking production models for these phases of the flocking process.

The research area was developed in an innovative industrial project with the aim of creating a substantially different model from those currently in existence, including the use of sensors, connectivity and data analytics (production data analysis):

In summary, with regard to this type of equipment, currently on the markets, the first two operations (a, b) of the five on these machines are carried out manually:

a. Pre-treatment (in the world currently performed off-line or by hand)
b. Glue application (in the world currently done by hand by an operator)
c. Flock application
d. Glue drying
e. Final Cleaning

The innovation was to automate them with the use of robots and specific tools such as plasma guns and precision glue dispensers, but in doing so the entire plant necessarily underwent a deep electronic evolution in all its phases. In fact, it is essential that the rubber components to be processed are automatically recognised and that all phases are automatically managed and monitored in an integrated manner.

It was thus necessary that the data recorded by the sensors and cameras were not only collected but processed during production and then, of course, continuously reprocessed to control and increase the efficiency of the entire production system (productivity, waste reduction, etc.).

As the five working stages are very different from each other, each requires special instruments for reading, handling and collecting data (e.g. pyrometers in the ovens, high tension control in the flocking area, self-regulating pressure valves in the glue area, thermometers and hygrometers for the flock distribution area, etc.).

So the innovation is not just the simple automation of the first two phases, but the study of an integrated system that collects very different data from different sensors, data that is then analysed and managed continuously.

Aigle thus developed some prototype line parts to implement an automatic and process system. The aim was to validate and demonstrate the technologies used in the industrial environment first at prototype level and then at real operational level, up to the qualification of the system and the demonstration of its applicability in the rubber profile production area.

Finally, an attempt was made to combine the specific raw materials (chemicals and flock) with the special requirements of the control system, which was then developed in such a way that profiles with the desired technical characteristics could be treated on the surface.

THE FLOCKED RUBBER PROFILE: TOWARDS TOTAL QUALITY

Specifically on automotive sector (and not only), the rubber profiles require various treatments to assure thermal insulation characteristics and resistance to weathering and abrasion. The application of these treatments makes it possible to:

- limiting vibrations (anti-rumble effect)
- facilitate mechanical sliding
- extend product life by limiting mechanical wear and tear and aggression of atmospheric components.

There are, however, several difficulties faced in automating the production process and managing the data and achieving this at the process and control level.

The research presented took in consideration the following aspects:

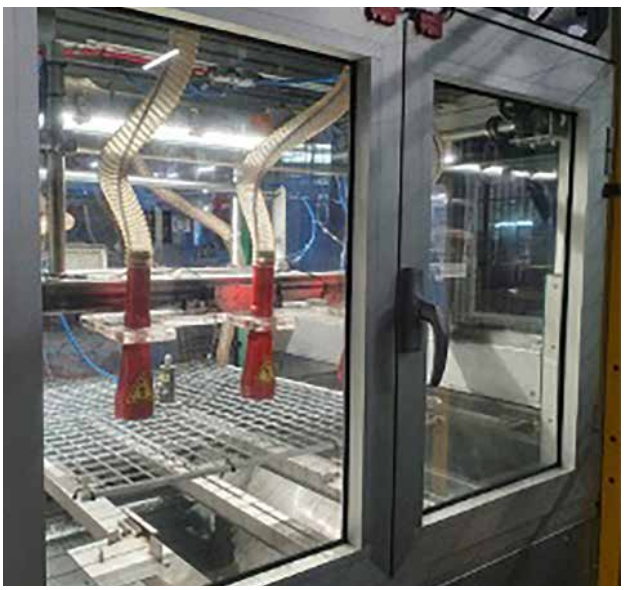
- automation and process control
- changing the shape of the rubber during processing (which obviously hampers product quality and repeatability)
- flockability of profile sections that are difficult to reach by flock fibres (presence of undercut areas).

Today, the growing need for automation of various mechanical parts of the automobile, first and foremost hatches, bonnets, and other non-automotive related areas, sees the use of flocked profiles on the rise. The increase in demand, however, requires rationalisation of production criteria and their control, and an increase in productivity.

At the same time, constantly rising quality standards require manufacturers of these components to make an effort to achieve total quality and thus production systems that are able to increase productivity while maintaining high quality control of the semi-finished product.

The reasons why there were currently no particularly advanced automated plants for the above-mentioned are mainly due to the following factors:

- rubber parts sometime are not maintaining a constant shape and position along the production line. This makes the use of robots difficult.
- the profile should be flocked not completely but only in some parts. Therefore, the application of spray glue would have to involve the use of masks; this would make the process expensive and more difficult but anyway possible) to automate.
- The difficulty of flocking on rubber lies in combining a special pre-treatment (plasma) and finding chemicals (glues and its additives) compatible with precision dispensers. In order create a wet layer of about 0.2 mm on the surface of the rubber product. This can only be achieved with spray techniques. Glues have also been found that cure at relatively low temperatures (in case



of PTE profiles), but still allow them to adhere well to the rubber. Pre-treatment, quantity and quality of glue distribution, flock flow control, electrostatic fields and drying temperature control are the parameters that this research has collected and managed with the aid of advanced measurement systems, automation and communication protocols that have made the process data easily accessible to the production control staff.

For profiles, the difficulties of flockability are multiplied by the fact that it is complex to reach the fibres evenly across the entire section of the profile. For this reason, it was decided to use the technique of electropneumatic flocking, which, by precisely mixing air and flock, allows the fibres to reach areas that are difficult to flock.

Moreover, the profiles do not always have a constant shape and position. We studied a solution using a cameras installed on the robots to correct the trajectories just before the process is started for limiting the problem. For these reasons, up to now the operators have always been obliged to operate manually and the need to automate the process has already been clearly expressed.

There are currently no alternative systems to flock that can guarantee the same performance on rubber profiles. A ‚textile' type product that precisely follows the surface of rubber objects is not available on the market. Furthermore, flock fibres can be selected for:

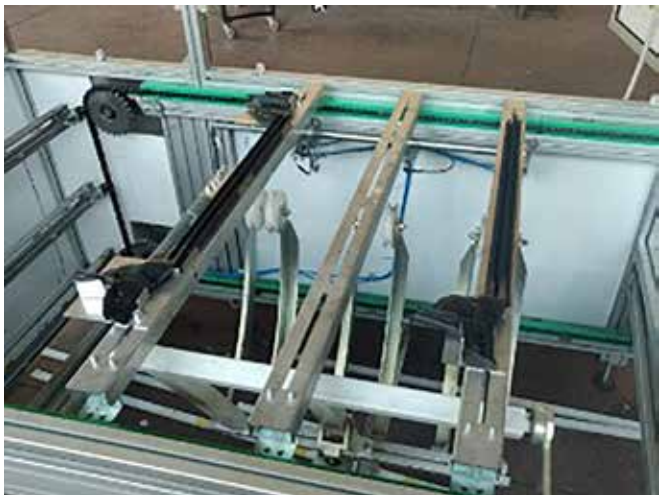
- diameter
- length
- colour

For rubber, polyester or polyamide flock is preferred as they are more resistant. However, the possibility of choosing the type of fibre and thus its mechanical performance can also allow for very varied uses.

THE FLOCKING LINE: INNOVATIONS

Several elements have therefore been adopted on the new flocking lines:

- The pieces are supported by a system of supports or pallets that move with a step-by-step movement. Compatibility with the support transport or carousel pallet systems used on these previously constructed flocking lines was studied in terms of mechanical, operating speed and product geometric compatibility. The supports, for example, are raised towards the operator by a system of automatic levers (controlled by sensors) that allow easy loading of the profiles onto the line. In this way, better ergonomics of the operator is assured during profile loading/unloading operations.



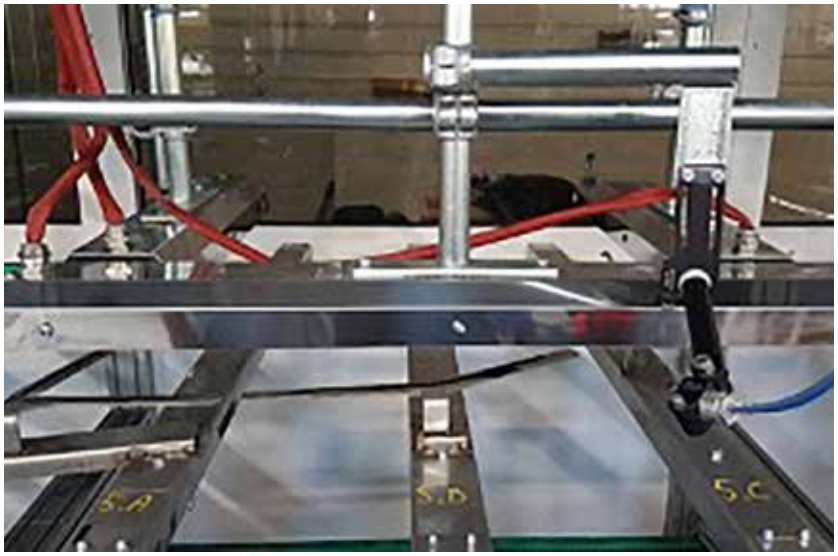
- In the first robot, the one envisaged for plasma pre-treatment, there is a camera equipped with appropriate lighting systems. The camera serves two distinct functions:
  - Identification of the type of profile to be treated in order to choose the recipe to execute

- Identification of the precise position of each individual part for referencing robots in order to carry out robotic operations precisely,

- Adhesive application, on this area, a spray gun was identified with the possibility of significantly varying the application rose, from very small, min 5 mm, to a max of 15-20 mm. The robot manages the application rose with a proportional valves that allows to vary the spraying characteristics according to the various areas to be treated with the adhesive:
  - small area for the edges for limiting the over-sprayed areas
  - wider area for the central zones to shorten the application time (essential to reach the productivity target). An advanced sensor is used in the glue distribution system to keep under control the flow of adhesive. This measures the adhesive passage flow in order to confirm the correct functioning of the system and will alert the operator in case of abnormal passing measurements that are not in line with the pre-set data.

- Flocking with electropneumatic guns for fibre distribution, with a special device for filtration and recovery of excess flock. The guns attached to a third robot or to movable axis devices, are built in special isolated material. Flock is carried through transparent pipes, the transparency of the tube permits to monitor the presence of the flock and the amount of fibre sent to the guns with an optical sensor. In this way we can control the inverter speed of the fibre flow fan with the signal received from the sensor. In this way, the quantity of flock arriving on the profile is optimised, and in the event of a blockage in the pipe, the system provides an acceleration of the fan speed to remove the blockage autonomously, without requiring operator intervention and a prolonged stop of the line. If the blockage persists. the sensor can command an alarm signal and line blockage.

- A flocking plant equipped with a variable intensity electrostatic field that contributes to excellent flock abrasion resistance. The flock distributor is enclosed in a climatic chamber with automatic humidity and temperature control to ensure consistent operation of the flocking operation.
- Drying is done using a system of infrared lamps. Each group of lamps is equipped with a pyrometer that allows the intensity of the lamps to be modulated once the target temperature has been reached. The lamps have different wavelengths depending on the curing stage of the adhesive.



- Suitably enclosed plant to minimise fibre pollution in the working environment.

Pressure switches in all exhaust fans are used to control the correct air flow and to signal any faults in the aeraulic circuits.

The system is managed by a PLC for the management of the main production parameters. The system also allows ‚recipes' to be set for specific products: the production parameters set can be memorised and re-proposed later for similar processes. Any line anomalies can also be monitored with analysis of their impact on productivity.

The PLC is connected, with a SCADA System (CitectSCADA or WinnCC Professional software), to a data collection PC offering:

- Synoptic diagram of the line highlighting the parameters used, workpiece recipe currently being proces sed, production in the predefined time frame, productivity, any deviations from target.
- The Plc has an internal counter that keeps track of the hours of operation and parts produced to keep the wear of consumable parts under control in order to alert the production manager for maintenance schedules.

The study involved the acquisition of a technical solution for robotic systems capable of guaranteeing quality and repeatability of the production model and consequently of the final product.

Safety systems, sensors and barriers to protect operators were also studied for future industrial applications.

The result in terms of plant capacity is approximately 180 angles per hour (depending on the shape of the profiles to be flocked).

In terms of defectiveness, a result of 2-3 % is achieved.

Going into even more detail, the flocking plant required a number of evolutionary elements to ensure product quality and control.

Systems were thus developed for:

1. Visualisation and management of profiles that have not correctly received flaming, coating or flocking phase. Visual markers indicate the profiles that remain in ‚quarantine' because an emergency has occurred during processing. The production process therefore does not stop to avoid creating waste on other profiles.
2. Identification and registration of the various batches produced with registration on plc
3. Management of parameters such as profile traversing speed based on processing time and dwell time in the oven. The parameters of oven temperature and profile traversing speed are stored e.g. every 10 minutes. In this way the operator has proof that the individual batch has been produced with constant and verifiable characteristics.
4. Control of the weight of raw materials (glue and flock) by means of loading cells for the management and control of consumption and for the warning of approaching product reserve so that the operator is activated for the replacement of the glue drum and the necessary loading of flock into the distributor hopper.
5. Flock flow control with alarms in case of low or no supply.
6. Control of electrostatic generator values with alarms in case of non-compliance with preset values.
7. In-line quality control systems with advanced visual/sensor systems

CONCLUSIONS AND PERSPECTIVES

It is believed that developments on the automatic flocking of rubber profiles in recovery can continue and open up new horizons for these production techniques as well as for other types of flocking lines as has been the case in similar experiments in the past.

The project evolved through the following preliminary activities:

a) Analysis of production methods and products for the definition of functional models to systematically identify the innovative potential of the flocking line for moulded profiles as well as the best technical and technological opportunities, also imported from other industrial sectors.

b) Reconstruction of the state of the art of technology and research in the relevant scientific and technical areas, highlighting which players have invested and developed new knowledge in technologies of potential interest and with what results.

c) Definition of potential technological opportunities and guidelines for possible subsequent implementation.

- Flocking with electropneumatic guns for fibre distribution, with a special device for filtration and recovery of excess flock. The guns attached to a third robot or to movable axis devices, are built in special isolated material. Flock is carried through transparent pipes, the transparency of the tube permits to monitor the presence of the flock and the amount of fibre sent to the guns with an optical sensor. In this way we can control the inverter speed of the fibre flow fan with the signal received from the sensor. In this way, the quantity of flock arriving on the profile is optimised, and in the event of a blockage in the pipe, the system provides an acceleration of the fan speed to remove the blockage autonomously, without requiring operator intervention and a prolonged stop of the line. If the blockage persists. the sensor can command an alarm signal and line blockage.

This led to:

- Summarise the state of the art of electronic technologies in the technical-scientific areas of product quality control and management (the profiles covered as described) and the production system to achieve it (evolved flocking lines)
- Develop new knowledge and apply it to the product and system based on the above
- Define new development targets for electronic systems applied for future new implementations

Dedicated software was therefore developed and commercial components adapted to specific needs were selected and integrated.

It is foreseeable for the future to be able to apply these technologies to industrial plants, certainly for rubber profiles, but in succession also to other industrial products of various kinds: gaskets for light industry, for consumer durables such as household appliances, for construction, etc.

NOTES

Flock Association of Europe

6. Odor and emission requirements for vehicle interior materials

Dr. Michael Holzwarth
HEAD OF COMPETENCE CENTER VIAQ, ODOR (IMAT-UVE GMBH NL STUTTGART)

Michael Holzwarth completed a chemistry degree at the Technical University of Darmstadt and then received his doctorate at the University of Hamburg. He came to imat-uve in 2005, where he quickly became the leading expert in emissions testing and, from 2008, part of the laboratory management. Between 2015 and 2019 he was the Head of Testing and Validation (laboratory manager) for the emissions test lab in Stuttgart and from 2016 he also had global technical responsibility for odor and emissions testing for the whole imat group. M. Holzwarth has been the Head of Competence Center VIAQ, VOC and Odor since 2019.

As an expert on the VDI/DIN-Commission “Air Pollution Prevention”, he is involved in the development of international standards for the investigation of VOC emissions from vehicle interior materials and VOC analyzes of vehicles. As a DIN delegate, he represents the German mirror committee (NA 134-04-04) in working groups for ISO/TC 146/SC 6 "Indoor Air", which develops and revises the standards of the ISO 12219 and 16000 series

Odor and emission requirements for vehicle interior materials

Since the 1980s, vehicle manufacturers have been concerned with the evaporation of organic chemical substances from plastics into vehicle interiors. Since then, numerous laboratory methods have been developed to test the suitability of a material for use in vehicle interiors. Despite the variety of existing test methods, these can be traced back to a manageable number of test groups. The test methods of each group are based on a uniform procedure. The variations within a group, which are usually rather minor, often only consider the individual preferences of individual vehicle manufacturers.

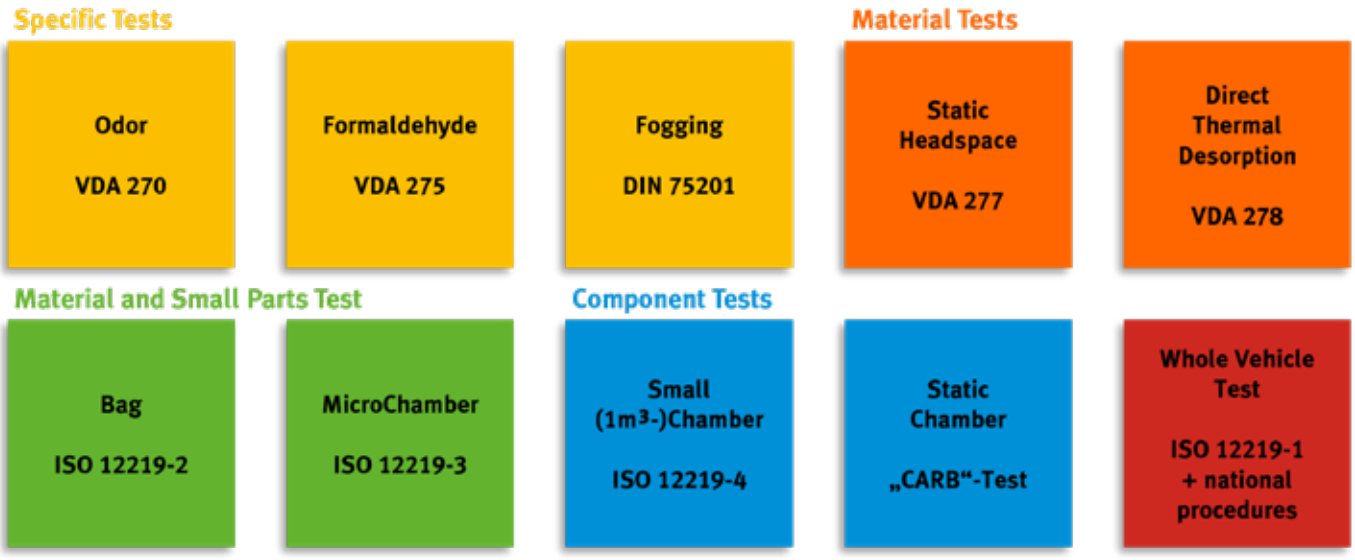


Illustration 1: Groups of emission tests, each based on a uniform or comparable procedure.

The tests used for a vehicle manufacturer usually never cover all groups. However, the three „specific tests“ for odor, formaldehyde and fogging behavior are used by virtually all OEMs. A material qualification by means of an overview analysis of the emissions of volatile organic substances (VOCs) by either a test according to VDA 277 type or VDA 278 is also typical. Increasingly, a chamber test (ISO 12219-4) is meanwhile being carried out (at least in addition) at the component level. The testing of complete vehicles (ISO 12219-1 or specific national procedures) is mandatory for their approval in some markets, but by its very nature it is not a direct requirement for suppliers.

Test Method	MB DBL 1000	BMW	VW VW 50180	Porsche PN 780	Stellantis CS-13398
Odor I VDA 270	×	×	×	×	×
Formaldehyde I VDA 275	×	×	×	×	×
Fogging I DIN 75201	×	×	×	×	×
Static Headspace I VDA 277	— / —	— / —	×	— / —	— / —
Direct Thermodesorption I VDA 278	×	×	— / —	×	×
Bag I ISO 12219-2	— / —	— / —	— / —	— / —	— / —
MicroChamber I ISO 12219-3	— / —	— / —	— / —	— / —	×
Small Chamber I ISO 12219-4/-6/-7	×	×	×	×	— / —
Whole Vehicle I ISO 12219-1	×	×	×	×	×

Table 1: Exemplary test requirements of some OEM present in the European market.

Carrying out an odor test in accordance with VDA 270 is deliberately kept relatively simple so that suppliers can implement this test themselves. A prepared test specimen is placed in a glass vessel (1 liter or 3 liter volume) and conditioned at a defined temperature for a defined time. The amount of material used as a specimen depends on the application of the test object as well as the size of the glass used. Conditioning time and duration result from the storage condition variant mentioned in the delivery instructions. Variant 3 (2 h / 80 °C) is currently established as the standard variant.

variant test specimen	application examples	quantity for 1 L-vessel	quantity for 3 L-vessel
A	clips, stoppers, spouts and other small parts	10 g	30 g
B	arm rests, ash trays, straps, gear shift lever bellows, sun shields and other components of medium size	20 g	60 g
C	volume materials such as insulation materials, foams, back foam carpets, door panels, headliner etc.	50 cm^3 respectively 50 g	150 cm^3 respectively 150 g
D	surface materials, genuine leather and backside laminated genuine leather, roll goods, upholstery materials	50 cm^2	150 cm^2

Table 2: Variant Test Specimen of VDA guideline 270 (issue 2022-05)

Variant storage condition	storage condition
1	24 h / 23 °C with water
2	24 h / 40 °C with water
3	2 h / 80 °C (60 °C) without water
4	2 h / 50 °C with water
5	2 h / 50 °C without water
6	2 h / 65 °C without water

Table 3: Variant storage condition of VDA guideline 270 (issue 2022-05)

After conditioning the sample in the glass under the required conditions, it is first allowed to cool down to a target temperature of 60 °C and then the smell in the glass is assessed in a rapid process according to a predefined rating scale. A grading system is used here, ranging from grade 1 (= not perceptible) through several gradations of feedback perceptible and disturbing to grade 6 (= not acceptable).

	6,0	not acceptable
	5,5	
	5,0	strongly disturbing
	4,5	
	4,0	disturbing
	3,5	
EVALUATION	3,0	clearly perceptible, but not disturbing
	2,5	
	2,0	perceptible, not disturbing
	1,5	
	1,0	not perceptible

Illustration 2: odor assessment scale according to VDA guideline 270

When dealing with test standards, special attention should always be paid to the issue date. In the case of VDA Guideline 270, e.g. the test specimen variants have been revised in a way that a clear distinction is now made between geometric and surface materials and there are corresponding quantity specifications.

Test Variants (VDA 270 | 2018-06)

variant test specimen	application examples	quantity for 1 L-vessel	quantity for 3 L-vessel
C	covering and insulating materials, films, foamed materials, carpets and other materials with large surfaces	50 cm^3 respectively 200 cm^2	150 cm^3 respectively 600 cm^2
D	genuine leather and backside laminated genuine leather	50 cm^2	150 cm^2

Table 4: Variant test specimen C and D of VDA guideline 270 issue 2018-06 (changes to issue 2022-05 highlighted in blue)

Test Variants (VDA 270 | 2022-05)

variant test specimen	application examples	quantity for 1 L-vessel	quantity for 3 L-vessel
C	volume materials such as insulation materials, foams, back foam carpets, door panels, headliner etc.	50 cm^3 respectively 50 g	150 cm^3 respectively 150 g
D	surface materials, genuine leather and backside laminated genuine leather, roll goods, upholstery materials	50 cm^2	150 cm^2

Table 5: Variant test specimen C and D of VDA guideline 270 issue 2022-05 (changes to issue 2018-06 highlighted in blue)

A difficulty arises from the fact that there are still specification documents that require the test specimen variant C for flat materials, although these materials would have to fall into variant D according to the new classification. Mercedes-Benz counters this circumstance with a clarification in its delivery specification DBL 1000. Here, the test of 200 cm² is required for these cases, which corresponds to VDA 270 with issue status from 2018. The background to this is the necessary comparability of results with the requirements for the test. To be able to switch to variant D of VDA 270 in the long term, the results of an examination according to this variant should also be submitted in an informative manner. In this way, new empirical values for this variant will also be collected. In the event of a future changeover, they can be used to make a targeted adjustment of the requirements.

The purpose of a test according to VDA guideline 278 is to determine VOC emissions from polymeric materials. The sample quantities used for this vary depending on the sample type:

- standard 30 ± 5 mg
- foam 15 ± 2 mg
- highly filled fibre compounds 60 ± 20 mg
- film-type samples 30 ± 5 mg
- leather 10 ± 2 mg
- paints 30 mm × 3 mm × 50 ± 5 µm
- adhesives or similar 30 ± 5 mg

The specimens are placed in thermal desorption tubes and heated to 90 °C in an inert gas stream for 30 min by an automated process. In this process, VOCs escape from the material (thermal desorption) and are collected over the entire thermal desorption period in a cold trap or on suitable adsorbent. After this phase, these substances are mobilized again by heating the cold trap or adsorbent as abruptly as possible and continuing to flush it with carrier gas. The substances to be determined are thus transferred to the separating column of a gas chromatograph (GC). There, the complex mixture is separated and detected in the mass spectrometer (MS) as individual substances (VOC measurement 1). After this first measurement, a repeat is made on a second sample in a separate tube at the same settings (VOC measurement 2). For a third measurement, the tube of the second measurement is thermodesorbed again, but this time for 90 min at 120 °C (Fog measurement) in order to also capture less volatile substances. As a result, the sum values of all detected substances per measurement are reported as toluene (VOC measurements) or hexadecane equivalents (Fog measurement) in the unit [µg/g] (mass of emitted substances per gram of sample material used). In addition, the substances of one VOC measurement and the Fog measurement are identified and quantified individually.

Illustration 3: schematic material test procedure according to VDA guideline 278

While a test according to VDA 278 is suitable for estimating the basic suitability of materials, a test according to ISO 12219-4 in an emission test chamber can obtain information about complete components. These are placed in an inert test chamber preset to 65 °C, where they are conditioned at an air exchange rate of 0.4 /h and a supply air humidity of 5 % r.h. Although the procedure described in ISO 12219-4 does not require this, the substance concentration in the test room is typically recorded as total carbon by means of an online FID (flame ionization detector) throughout the test.

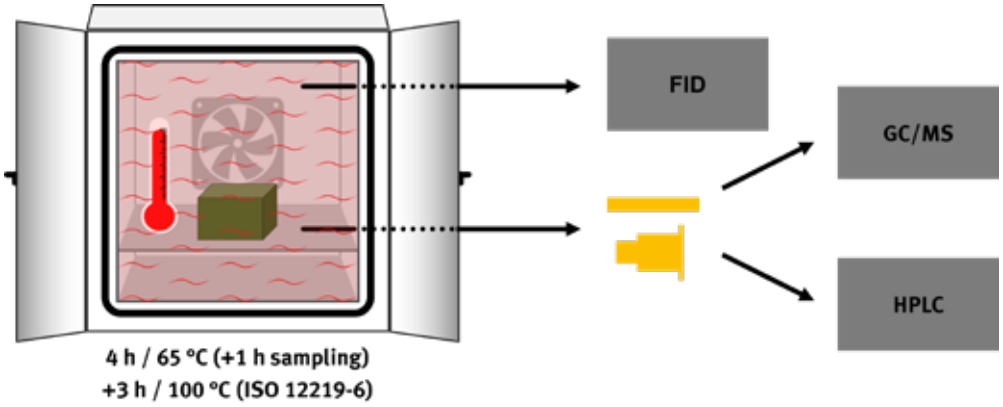


Illustration 4: schematic component test procedure according to ISO 12219-4 (and ISO 12219-6)

4 hours after the sample has been placed in the test room, air samples are taken from the air outlet stream of the chamber and passed through various adsorbent media that allow later analysis for specific substance groups (often aldehydes and ketones, amines, phthalic acid esters, glycols and glycol ethers as well as N-nitrosamines). For these investigations, which can be referred to as „target analyses“, high-performance liquid chromatography systems (HPLC) are often used. In any case, a sampling is carried out on a universal adsorbent for a VOC overview analysis. The information on VOC totals and individual substances is usually given as mass concentration values [µg/m³], but sometimes also as (time-averaged) emission rates [µg/(m³h)]. Optionally, the test sequence according to ISO 12219-4 can be followed by a second conditioning phase according to ISO 12219-6. In this case, the humidification of the supply air is switched off after a total of 5 hours and the temperature in the test room is increased to 100 °C. 8 hours after the sample has been inserted, further sampling is provided for in accordance with the standard. Often, however, these are omitted and only the recording of the FID is evaluated.

In routine, chamber tests according to ISO 12219-4 are also often combined with an odor assessment. In accordance with ISO 12219-7, odorless bags are filled with the outlet air from the chamber immediately before the sampling at 65 °C test room temperature. For evaluation by the odor panel, these are then installed in a specially provided presentation device, which presses the chamber air out of the bag by means of compressed air, so that one panelist at a time can use the air flow from the bag for evaluation.

photograph 1: odor assessment according to ISO 12219-7 from bags using a presentation device

As an alternative to this method, the evaluation of the chamber air can also be carried out directly at the air outlet or in the moment of opening the test room door after completion of the test. In all cases, the rating scale used here is also that of the VDA guideline 270.

	BMW	Mercedes-Benz	VW	Volvo
Standard	GS 97014-3/-4	ISO 12219-4 (DBL 1000)	PV 3942 (VW 50180)	VCS 1027,2769
Volume	variable	1 m³	1 m³	variable
Equilibration 65 °C	4 h	4 h	4 h	2 h
Equilibration 100 °C	-	-	-	-
Adsorbent (VOC screening)	Carbotrap 300	Tenax TA	Tenax TA	Tenax TA
Odor Assessment	Bag + PureSniff (1+3 diluted)	Bag + PureSniff (1+3 diluted)	direct (chamber door)	direct (air outlet)

Table 6: OEM requirements regarding chamber emission testing and attached odor evaluation

Contrary to common assumptions, there are only a few legal requirements for air quality in vehicle interiors worldwide. Binding regulations currently only exist in the Russian Federation. These relate to formaldehyde, saturated hydrocarbons (up to and including C7) as well as the inorganic Nitrogen oxides NO, NO2 and carbon monoxide CO. Testing is carried out in driving mode as well as at idle, whereby impurities introduced into the vehicle from the outside are also recorded. Other test methods are broadly equivalent to the ISO 12219-1 procedure or are at least approximately comparable. From 07.08.2027, according to an amendment to the REACh directive published in mid-2023, vehicles may no longer be placed on the market in Europe whose formaldehyde concentration exceeds a value of 62 µg/m³ in accordance with ISO 12219-1 (Ambient Mode). In addition, there are binding measurements for the Japanese and South Korean markets. However, the legally enshrined target values do not restrict the respective market access but serve to inform consumers. A legal regulation originally planned for 2017 in China (planning since 2004) has not yet been enacted.

In Germany, the toxicologically derived substance specific precautionary guide values and the hazard guide values (which also apply to vehicle interiors) of the Committee on Indoor Guide Values, are still legally relevant. They provide valuable support in assessing risks to the health of exposed people.

Substance	AIR guide value I [µg/m³]	AIR guide value II [µg/m³]	GB/T 27630 [µg/m³]	MOLIT Not. 2019-144 [µg/m³]	JASO Z 125 [µg/m³]	REACH Annex XVII [µg/m³]
Benzene	— / — *	— / —	50	30	— / —	— / —
Toluene	300	3.000	1.000	1.000	260	— / —
∑ Xylenes	100	800	1.000	870	870	— / —
Ethylbenzene	200	2.000	1.000	1.000	3.800	— / —
Styrene	30	300	260	220	220	— / —
Formaldehyde	100	— / —	100	210	100	62
Acetaldehyde	100	1.000	200	300	48	— / —
Acrolein	— / —	— / —	50	50	— / —	— / —

* provisional risik-related guide value: 4,5 µg/m³

Table 7: exemplary legal testing requirements with limit or target values for whole vehicle interior emissions

The target and limit values for complete vehicles are monitored by the manufacturers and used to control emission requirements for suppliers. However, a mathematical summation of the test results of e.g. chamber tests of the components for a substance concentration in the entire vehicle is not possible (∑ substance concentrations of all components ≠ substance concentration in the entire vehicle). Target values for emission tests on components and material samples can therefore only be derived based on empirical values and

considering the material, the state of the art, the quantity of the respective material in the vehicle, the position of use as well as the typical indoor temperatures prevailing there.

Illustration 5: information and background data used for setting up OEM requirements

NOTES

Flock Association of Europe

7. A new concept for flock density verification on a microscopic scale

Richard Galfi
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First exposure to Flock by Johannes Hofmann at the iENA Exhibition in Nürnberg

ABSTRACT

Unlocking new ways to verify flocking qualities using visual aids. The goal is to find inconsistencies in flock and in the long run, to optimize flocking procedures to ensure quality which can also be measured using this procedure. When observing surfaces with flock which have concave on convex textures it becomes apparent that areas which are difficult to reach have a lighter color than others which are mostly flat. This project assumes that there are inconsistencies in the flock which cause this visual appearance. This might not be a major interest for the average end consumer at the beginning, but it might be due to the flock not being consistently pulled into the adhesive, which would cause it to fall out eventually. But flock is not just about visual appearance to an end user but also about sensitive technologies in other industries which cannot accept unpredictable physical parameters and wear.

It seems likely that the procedure of flocking must be altered to comply with the needs of a consumer who might be an average end user or larger industry. To confirm this multiple sub symptoms, must be checked, which now are considered to be, adhesion depth, orientation and flock density.

Weaknesses and requirements

The process requires human intervention instead of a fully autonomous procedure and is time consuming. There is a large overhead in the means of physical equipment which include:

- a reflected light microscope
- a compatible camera and adapter
- a light source
- the provided controller assembly
- a sufficiently powerful computer with the recommended minimum specifications of:
  - a CPU with 200 GFLOPS or more at FP32 single core (~R 3800X)
  - a CUDA 12 compatible GPU with 5 TFLOPS or more at FP32 (~RTX 2060)
- The provided computer software

The operator for the software must be instructed and is required to have an intermediate understanding of algorithms, photography, and images respectively. These obstacles could be overcome in the future when a large amount of experience data is available, which we hope to gather if institutions show interest in this procedure.

When using the assembly, it is crucial to have a shake resistant environment for the microscope and in ideal conditions, be able to control the lighting and air movement around the sample during the imaging for more precise results.

In case flashes are used instead of a static light source, the environment should also not interfere with the wireless signal transmission and should also be resistant to it as well as the bright flashes used.

Utilization

Primarily this procedure targets the density. For that, the flocked part is cut up to pieces which fit under the microscope lens. After that, reference measurements will be made using flat parts of the target part and other parts to check part-to-part consistency as well as measurements in places of interest. The datasets will be loaded into the program and the settings must be adjusted on the references to the measuring setup and flock parameters using trial and error.

Afterwards all the datasets are swiftly checked with the settings to ensure that they comply with the settings and run on the program. The calculated density is yielded, and they can be compared to the ideal, expected, and relative (to reference measurements) densities. This information reveals where most flock is lost during the adhesion process. How these potential inconsistencies might be fixed is only to be debated once the exact conditions are evaluated for a certain occurrence.

First, a reference sample is put under the microscope and test images are manually taken to configure the cameras settings. Excellent lighting is crucial for the data gathering because long exposure and a high iso setting contribute to more image distortion, which increases the difficulty or even prevents the adjustments in the software later. After the area of interest is in frame and partially sharp, one continues the procedure using the software in a browser device connected to the access point of the raspberry pi from the assembly.

The next step is to determine the two extreme points of the recording where all fibers are sharp somewhere in between. It is recommended to note down these endpoints for later recordings to make them as comparable as possible. Based on trial and error gathered information, the number of steps is chosen for the procedure. Usually, it is sufficient to use somewhere in the neighborhoods of 50 to 100 pictures as the algorithm mostly uses information from the fibers becoming less sharp over the course of images anyway and it is not necessary to have near duplicate images like sometimes beneficial with neuronal algorithms. The number of images and or the distance between each image should also be remembered as this also comes handy later. Next, the recording is started after making sure that the camera is connected to the raspberry pi. Resulting images are loaded into the program and it is dialed in as mentioned above.

The following part is essentially a repetition of the actions before, but it is crucial to perform this precisely. The next part of interest is placed beneath the microscope lens making sure not to alter the lighting (from for example flashes) too much. Then, the endpoints are checked again because the new object or section might have a ticker backplate which offsets the sharpness points by the difference in thickness. At best the difference between the start and endpoint stays equal and they are offset by the same amount. Then, the recording is started again using the remembered image count value.

This last step is repeated for all areas of interest, and they are all run on the program on the computer. The output can now indicate the flock distribution visually and numerically. At last, the information must be interpreted, optimally regarding the other outputs and reference value(s). Further information will be provided in the live presentation which will also hopefully include real world numbers and first results from the research.

NOTES

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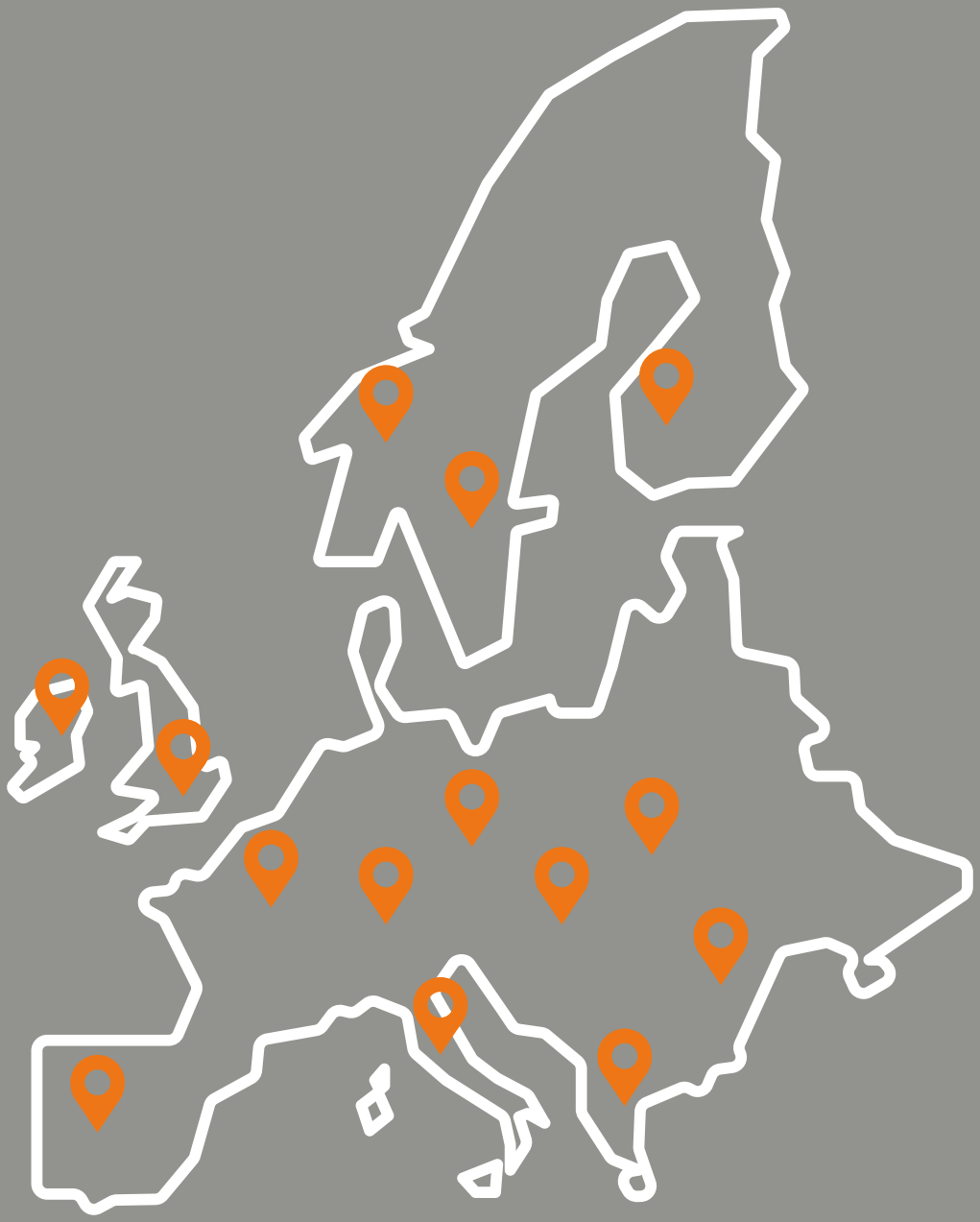

ALL ABOUT FLOCK

THANKS FOR YOUR ATTENTION.