THINK OUTSIDE THE BOX: FILM TYPE CONTAMINATIONS, THEIR IMPACT AND WAYS OF DETECTING AND AVOIDING

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Abstract: Cleanliness of surfaces of components is an important property in many industries. Contaminations during production processes cannot always be avoided despite the use of modern technologies. However, sufficient cleanliness is essential for processes which come afterwards, for example mechanical joining or coating. Next to particulate contaminations film type contaminations become more and more the focus and are to discuss in the following.

1. INTRODUCTION

In many fields of industry, cleanliness of parts surfaces is an important quality characteristic for a reproducible process. The considering of this fact is increasing tremendously. The reason is that despite using modern manufacturing engineering, contaminations cannot always be avoided. Therefor knowledge of parts cleanliness is a basic requirement to be able to rate effectivity and efficiency of the cleaning process and to guarantee a high and stable quality of the finished product. While in the last years particular contaminations were in main focus regarding a more sophisticated process chain, film-type contaminations are being observed increasingly as a quality affecting factor.

2. DEFINITION: FILM-TYPE CONTAMINATIONS

Film type contaminations usually are thin and coherent (and not particulate) layers of unfamiliar and unwanted substances on a part or the whole surface of a component.

3. SOURCES AND EXAMPLES OF FILM TYPE CONTAMINATIONS

Production aids like coolants, drawing oil, cleaners, solvents and anticorrosives are the main source of film type contaminations. Packing material, sweat, hand lotion, finger prints and even contamination, which is transferred in the air, so called air born molecular contamination (AMC), are potential sources and have also to be taken into account.

Usually film-type contaminants get on the surface during production process and are not totally removed in cleaning process because of missing information about that type of contamination. That is why the daily work of manufacturers and providers of cleaning systems becomes more and more ambitious. But an increasing number of production processes and final applications are depending on the cleanliness of the components regarding film type contaminations.

The following figure shows potential and underestimated sources of such contamination based on a standardized process chain. Components can be contaminated during the whole process starting from receiving materials to production, cleaning and finishing until shipping with a certain kind of packaging material.

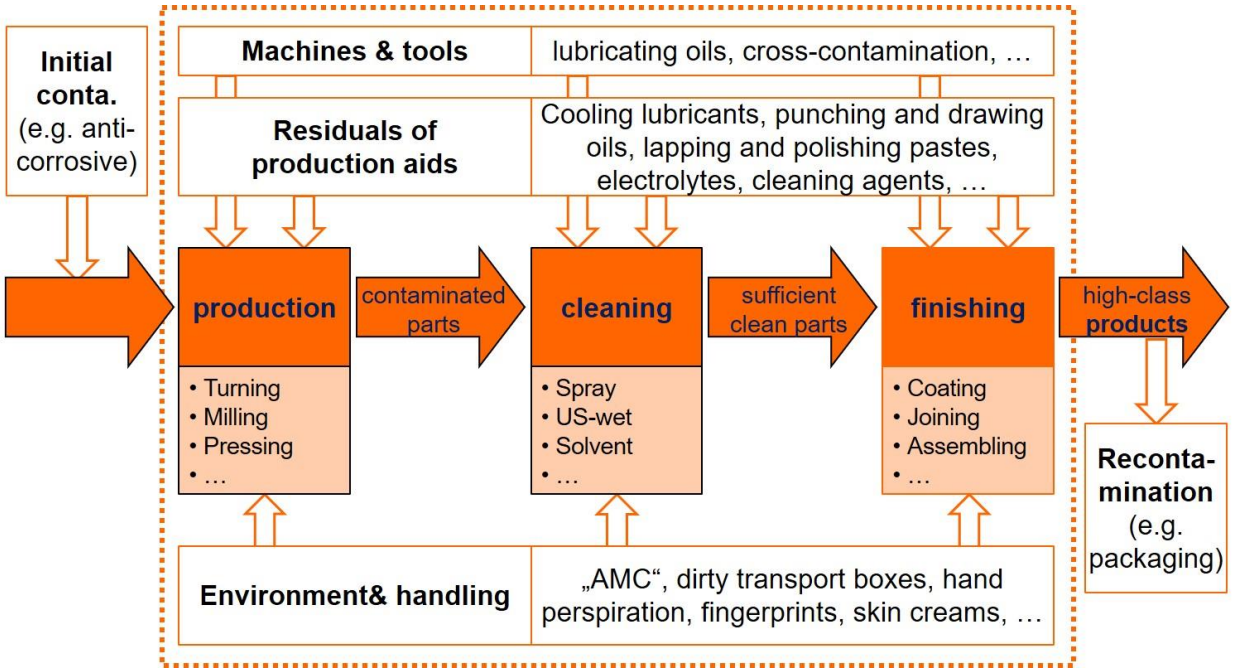

Figure 1: Sources of contamination in a process chain

Raw materials and semi-finished products are being processed with different suitable production methods. Afterwards they are available as dirty parts and amongst others also contaminated with film type contaminants. That's why they should be controlled before the next step to determine the degree of contamination. After such analyzation, the contaminants can be removed by coordinated processes according to the degree and type of contamination. These processes should be subject of a specific control process related to their efficiency and disturbances. Suitable measurement and test systems shall attest the sufficient cleanliness of the components after cleaning. The process steps between manufacturing and finishing are essential to finally achieve the quality according manufacturer's specification. Finishing and packaging are the latest steps in this production process and have to be chosen wisely to keep quality level. Overall handling and environment have to be in control and trained periodic.

4. CONSEQUENCES OF FILM TYPE CONTAMINATIONS

The previous figure shows that the risks of contaminations on components are very versatile and not focused on a certain field of industry. Production aids as the main source of contaminations are used in many manufacturing industries.

The following examples show how film type contaminations can influence processes if cleanliness is not monitored and contaminations are not removed properly.

- Cross contamination of whole systems in sensitive environments, for example clean room, sterile rooms, grey area, ultra clean room
- Coating errors and as a result optical defects and influence on functionality of components and assemblies (e. g. corrosion resistance, mountability etc.)
- Unexpected outgassing which can have a negative influence on process stability (e. g. processes with a vacuum basis)
- Contamination of processing systems, for example failure of optical components in laser systems
- Negative influence on quality of mechanical joining like incorrect welding seam, shrinking processes etc.
- Cytotoxic effects or insufficient biocompatibility of implants or instruments etc. in medical technology restrict durability, reliability and security of patients
- Limit of life durability of sensitive components
- Properties of optical components are influenced, for example resolution of optical systems

5. DETECTION AND AVOIDING OF FILM TYPE CONTAMINATIONS

The essential requirement for optimizing manufacturing and cleaning processes and to avoid contaminations is the knowledge about cleanliness or rather the degree of contamination. That is the only way to process a specifically controlled efficient cleaning of components to avoid waste of time, money and claims of customers. This cleaning process should be divided in different steps: before, between and final cleaning according to the final specification.

Nowadays not only particulate contaminations are in main focus, for which standardized measurement methods and threshold values are existing. The best known are documented in ISO ® 16232 ″Cleanliness of components“ and in VDA 19 ″Technical cleanliness“ in VDA QMC.

Today it is also the task to provide the evidence of film type contaminations close to the process chain in a non-destructive, geometry-independent and qualitative and quantitative way. Problematic is the absence of existing standards and threshold values for the complete process and supply chain.

Especially parts from suppliers can arrive in very different states of cleanliness. There is a chance that these parts cannot be cleaned in a standard cleaning process because of their degree and type of contamination. In addition, there can be residuals of unknown production aids on the components for which a standard cleaning process is not designed. In the end the effect of cleaning is insufficient and several additional cleaning steps like manual cleaning need to be done; but only the degree of cleanliness after the standard cleaning process is known. If not, interfering residuals may remain undetected on the surface if cleanliness control is not suitable or missing at all. Mechanical joining or finishing processes can be disturbed and cause economic damages for the end user. Highly contaminated parts can contaminate sensitive environments which is a high risk in special clean rooms.

To achieve efficient, secure and stable parts cleanliness you need to ensure the efficiency of the cleaning system. By measuring the state of cleaning before and after every cleaning process step you can rate and optimize your cleaning system.

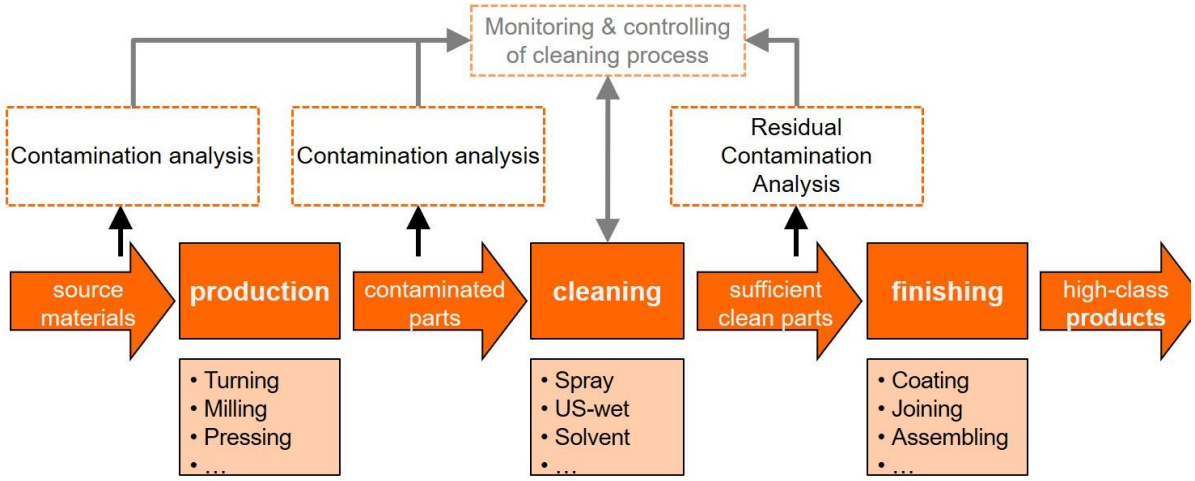

Figure 2 Use of appropriate measurement technology in a process chain

There are many different methods to check film-type contaminations the simple way, for example visual control, test ink, contact angle measurement or fluorescence measurement. All these methods only allow a qualitative or at best a semi-quantitative (comparing) valuation of the state of cleanliness which can provide subjective results often depending from who did the measurement. Furthermore, these methods cannot provide an indication of origin or causes of film-type contamination.

Figure 3: summary of measurement systems and methods

In opposite of the named simple methods there are as well complex analyse systems (for example TOF-SIMS, XPS, TD-GCMS) which are able to provide a very high content of information. But these systems have some disadvantages. Some systems are limited regarding the size of their sample vessel, others only perform measurements by destroying the samples or by using a solvent to remove the contamination and analysing these substances. Those system need to be operated by high qualified personnel. A measurement at-line, which means near the process chain, is not possible.

The cleanliness measurement system VIDAM ® relieves film type contaminations from the parts surface without destroying the sample. The analyzation takes place in a hermetically sealed chamber. In a fully automatic measurement and analyzing process the parts or assemblies are characterized under consideration of the whole surface independent from geometry. The automatically report tells you the type of contamination (qualitative) and the mass of contamination in g/cm² (quantitative). The detection range for film-type contamination lies usually between 100 mg and 1 µg. The substances can be identified since reference spectra database.

6. SUMMARY

Testing parts for chemical or film-type contaminations gets more and more in the focus in many different industry fields. To reduce or even avoid film-type contamination in the whole process chain, it is important to perform cleaning or treatment processes at a state-of-the-art-level. These processes should be validated several times. For achieving, the uses of measurement devices are highly recommended or even necessary. Such devices enable detection of sources of contaminations, determining of threshold values to declare specifications and developing of a reliable process chain of high quality with a sufficient cleanliness as a basis.