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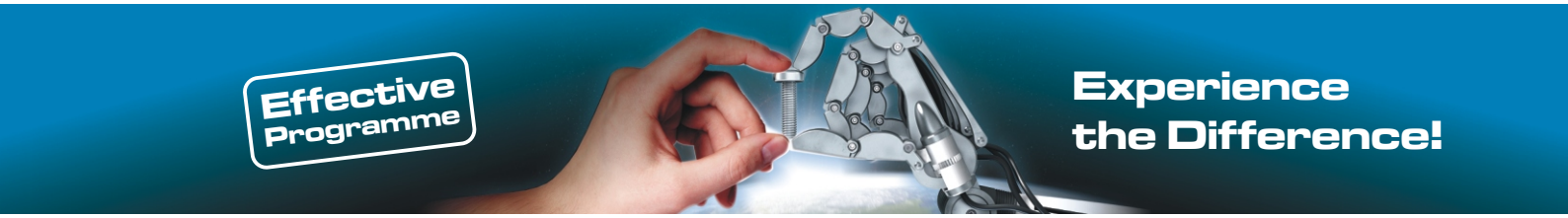

Arnold Umformtechnik: CleanCon® means "Technical Cleanliness"

The need for "technical cleanliness" of functionally relevant components is increasing – with its "CleanCon® concept Arnold Umformtechnik GmbH is setting the standard for technical cleanliness of components – an in-house, high-specification test laboratory is available – test specifications are drawn up with the Client.

(Forchtenberg). As the specialist in intelligent fastening solutions and as supplier to the automotive industry, Arnold Umformtechnik GmbH is particularly affected by the VDA 19 guidelines entitled "Testing for technical cleanliness – particulate contamination on functionally relevant automotive components". Following increased customer requirements with regard to "technical cleanliness" - in other words the limitation of surface contamination to particle sizes of less than 200 µm to 400mm – as early as 2005 the fastener specialist from Forchtenberg in South-West Germany had already started work on a development project, working in close cooperation with the Fraunhofer Institute. Among other things the cooperative venture developed the inspection criteria that would be used to classify product characteristics on the basis of these regulations. With its intensive groundwork, in CleanCon®, Arnold now has a set of inspection specifications that set the standard for permitted contamination. In this way quality requirements can for the first time be compared using "Technical Cleanliness" as a measure.

With the trend towards miniaturisation components and assemblies are getting smaller, but at the same time are becoming increasingly complex and more efficient. In many cases it is microscopically tiny particles that cause malfunctions on mechanical or electronic components. Besides the actual design of the product, its assembly into the application, the way it is handled and transported to the assembly site, and the materials in which it is packed, all

Fig. 1. Arnold's test laboratory

have a crucial effect on the degree of "technical cleanliness". Particularly during manufacture and processing and in the case of what are known in the logistics sector as C-parts – items such as nuts and screws – residual contamination can occur, becoming deposited onto the components in the form of particles that can vary from fairly large to tiny. At Arnold control over particulate contamination is an important requirement in order to achieve the necessary quality throughout the entire production process through to delivery of the product.

The Arnold Group is a wholly owned subsidiary of the Würth Group, which, with over 60,000 employees and with 384 companies world-wide operates on a global basis with earnings of over 7 billion euros.

Component cleanliness becomes a quality characteristic

Throughout the value added chain the potential for contamination by particles is wide-ranging. Although to a great degree the influencing factors during production – for example of a steel screw – can kept under control, there are other ambient conditions, such as temperature and air humidity, with will produce varying measured values for parts that are identical in construction. Subsequent coating procedures and jogging processes used to assemble and pack parts have also proved to be further contamination drivers.

At Arnold Umformtechnik "Technical Cleanliness" is the factor that most

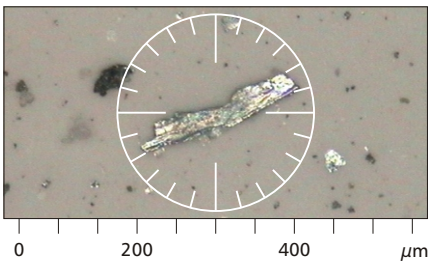

Fig. 2: The size of a particle of contamination.

affects the quality, function and service life of its products and assemblies. In particular this means functionally relevant components in modern motor vehicles. Continuous improvement measures ensure increased quality requirements. The activities implemented at Arnold cover the design, manufac-

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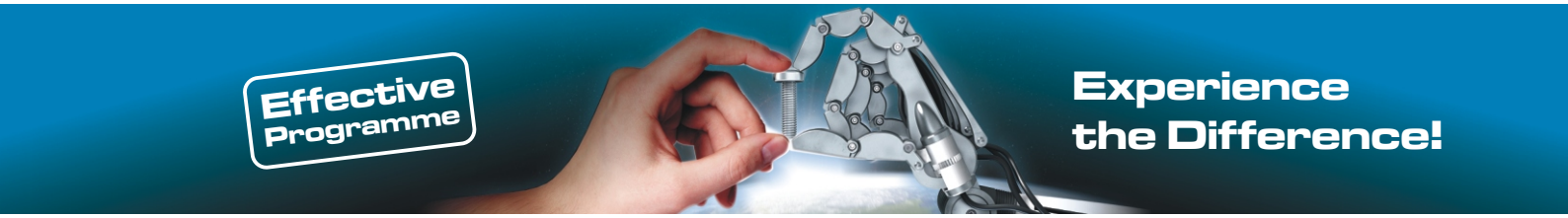

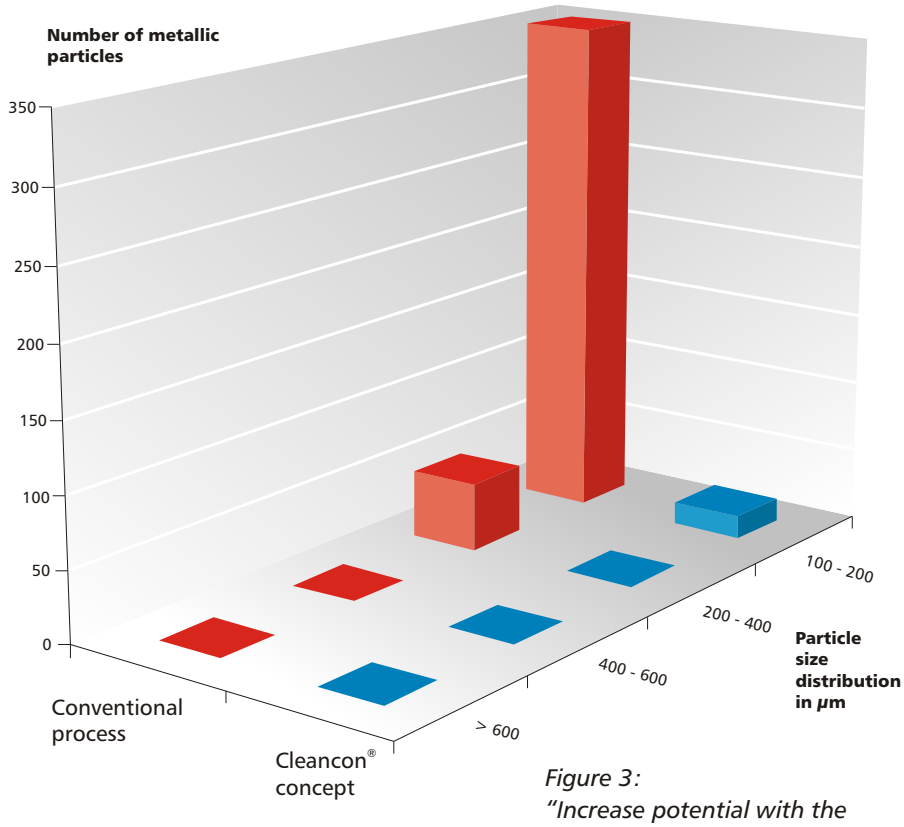

Figure 3:
"Increase potential with the Arnold Cleancon® concept"

VDA 19

The VDA 19 guideline drawn up by the Quality Management Center (QMC) at the German Automotive Association (VDA), in cooperation with the Fraunhofer Institute for Production Technology and Automation (IPA), provides for the first time a description of how particle contamination caused by production, such as chips and dust, can be quantified. It is not concerned with film contamination.
VDA 19 applies to function-relevant automotive parts, such as components for fuel systems, oil circuits, braking systems, coolant circuits, hydraulic systems, and airlines. The guideline sets out methods and procedures for collecting and analysing particles, in order to assess and compare the "technical cleanliness" of surfaces and surface areas of a component.

VDA 19 does not classify the condition of the surface into "cleanliness classes", i.e it does not establish the quantity, size and type of articles that are permitted from a technically functional view .

ture and packaging of the end product.

Cost/benefit is calculated when the limiting values are established

The VDA 19 guidelines issued in November 2005 quantified for the first time the particulate contamination caused during manufacture, such as swarf and dust. It specifies methods and procedures that can be used for extraction purposes (i.e. particle recovery) and for analysis. VDA 19 does not provide a grading as to the cleanliness classes that can be achieved for each product. Limiting values concerning the quantity, size and type of permitted particulate contamination from a technically functional viewpoint can be set for each item. These limits are generally established in conjunction with the customer, who has the relevant technical and functional expertise, and who knows the requirements of the product and is aware of the consequences of particulate contamination.

Since, from an economic point of view, quality and cost are always balanced in a causal relationship, the importance of establishing limiting values for particulate size or quantities increases in accordance with the way the component is priced. In general the limiting value established for residual contamination depends on how the part will be deployed in the component, or on the surface specific to the product. So, the more demanding the requirements for "technical cleanliness", the greater the cost of the product.
Electronic and hydraulic component assemblies set much higher demands for "technical cleanliness" on each element of the assembly, than do mechanical parts, for example. In some circumstances particle sizes of 200 mm – about the thickness of a human hair - can massively affect the electrical currents on a PCB populated with tightly-assembled cross-sections, and cause total failure of the downstream components. The customer's limiting value requirements will be correspondingly higher for such parts and these will need to be taken into account at the manufacturing and distribution stages. Conversely, a particle of that size would not affect the functionality of a robust mechanical fastening. Here, the residual contamination limits will be much

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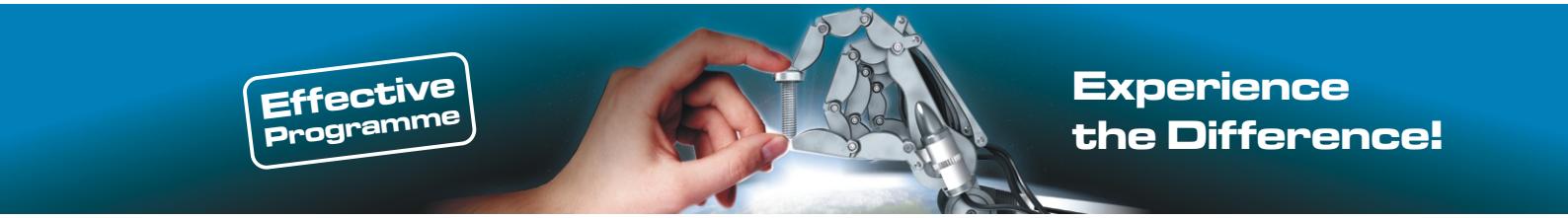

lower, and this will be reflected in a much lower pricing format.

"Technical cleanliness" becomes a product characteristic

In the light of what have always been rather general requirements imposed by its customers which simply state maximum permitted values for contamination on products, Arnold Umformtechnik reacted by drawing up its "Cleancon®" processes which it uses to implement the cleanliness requirements. For the first time customers have available test procedures that can be used to classify "Technical Cleanliness" as a product characteristic, so that comparisons can be made. The range of influences on test conditions is wide. It is rare to be able to carry out standard processes. The requirements are individual to customers, and need to be worked out individually with customers.

Limiting values need to be defined in a form that is adapted to the design. It is also necessary to establish when, where, and how the samples will be taken. The same applies to the extent of sampling in relation to the proportion of surface area. Agreement needs to be reached on the laboratory conditions and the extraction procedure – ultrasound cleaning or spray flushing – as well as on the analysis procedure to be used – gravimetric or particle size ascertainment. Arnold provides support by offering its experience in deciding upon and developing the testing procedure, and by making its test laboratory and its equipment available to customers.

To sum up

With CleanCon® Arnold meets defined cleanliness requirements. The company has developed the test specifications necessary to achieve this and these are helping to keep control over the very many influencing factors. For the first time a requirement has been created to provide a procedure for comparing the results of residual contamination inspections and for setting defined limiting values. A process has therefore been provided that takes both quality and cost into account, and, depending on the requirements, permits reproducible individual product characteristics.

Analysis filtration to define component cleanliness

In most cases fluid is used to detach the particles from the component so that they can be recorded on the technical measuring instrument. This is generally carried out in an ultrasound bath. The particles are collected on an analysis filter, dried in a defined procedure, and the particle distribution depending on requirements evaluated by means of gravimetry or microscopy. The result of the measurement depends to a great degree on the test procedure. The capability of the measuring instrument used also plays an important role. The test procedure selected must be adhered to scrupulously.

Gravimetry for evaluating residual contamination

The particle load on the test object is defined by the increase in mass. The analysis filter is dried and weighed both before and after filtration. Gravimetry supplies only the total mass of the particle load, but does not permit a conclusion to be drawn regarding the size distribution of the particles on the analysis filter.

Microscopic evaluation of residual contamination

The evaluation of the particle filter using a light microscope, by means of the transmitted light and impinging light procedures makes it possible to distinguish between metallic and non-metallic particles. The result supplied by this analysis is the number and size of the detached particles. Since component function can be affected by a single or just a few critical particles, it is necessary to count over the entire surface of the analysis filter.

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