

Construction Guidelines

Inserting

A method known from earlier days of working with Duroplast, for bonding metal and plastic parts together is pressure coating or extrusion coating of metal inserts. The process is also used in thermoplastic injection moulding. If the physical properties of the thermoplastics are considered when processing and for their longterm behaviour, the result is often unsatisfactory from both an economic and a quality point of view.

- . the metal parts must be pre-heated,
- . loading the parts into the injection mould tool is very costly, whether by hand or by robot,
- . extended – and in the case of manual loading – irregular cycle-times for the injection moulding adversely affect the quality of the plastic parts,
- . the injection moulds are subject to extra wear and tear in the area of the insert loading,
- . the manufacturing tolerances of the loading parts must be within unrealistic narrow limits,
- . extrusion-coated metal inserts hinder contraction of the plastic when solidifying and cooling off.

This always results in very high tangential stresses, which often lead to formation of cracks. As a rule one tries to absorb these stresses with excessive wall strengths surrounding the inserted metal part. Such accumulations of material are unhelpful for achieving reasonable cooling times for injection moulding.

Plastics with a high stress-strain ratio, such as for example Standard Polystyrene, are particularly susceptible to stress fractures. All other thermoplastics too, though, can fail in their long-term behaviour under the influence of weathering or chemicals which trigger off stress fractures. One reason for using ultrasonic inserting, which should not be ignored, is the considerable saving in energy.

For the reasons already stated, an experienced designer will abandon injection moulding of metal inserts, in favour of technically better solutions achieved by ultrasonic inserting.



Design 1 – 4

In principle, construction of an ultrasonic produced metal insert always contains the three elements described below:

Reference diameter (A), which has the task of positioning the metal part precisely in the hole of the plastic part. The height of this zone must be sized large enough so that in this area the plastic part does not melt under the effect of the ultrasonics. This would result in movement away from the inserting axis. **Undercut (B)**. One or several notches, into which the molten plastic flows, to fix the insert in the axial direction. In this way high pull out forces are achieved. **Knurling (C)** or lengthways grooves take care of the torsional hold on the insert. Sharp edges encourage stress fractures and must at all costs be avoided.

The standard range of an ultrasonic insert manufacture in general covers three types:

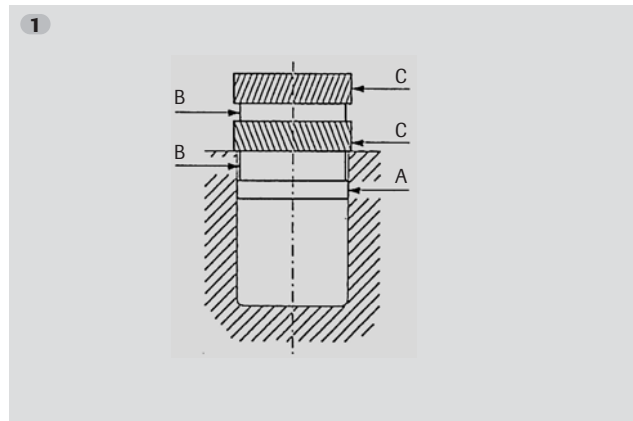
- standard threaded insert
- threaded insert with flange
- insert with set screw

Inserting Procedure 5 – 8

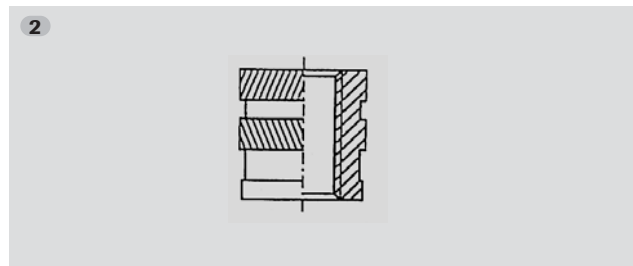
In most cases the sonotrode acts directly on the metal part. The part to be inserted is to be considered as an extension of the sonotrode, i.e. it is excited by the sonotrode into vibration with practically equal frequency and amplitude. In this way the heat energy between the surface of the part to be inserted and the surface of the plastic part becomes molten.

The insert sinks into the molten plastic under the combination of the amplitude and force applied by the ultrasonic system. The molten plastic flows into the profile of the insert and quickly solidifies when the ultrasonics are switched off. The volume of affected plastic should be equal to or greater than the volume of the profile in the insert. Blind holes should be about 2 mm deeper than the insert so that any surplus molten plastic is forced down into the hole.

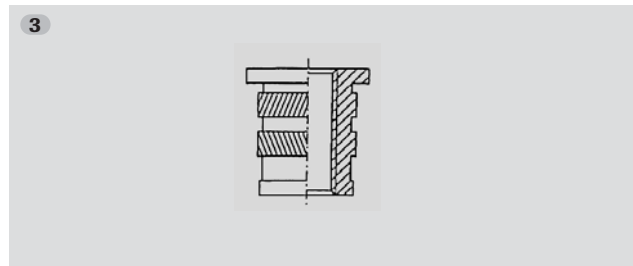
To avoid unnecessarily high pull out forces being applied to the threaded inserts, they should stand slightly above the surface of the plastic. In this way the pull out forces on screwing down are supported on the top surface of the insert and not on the plastic part.



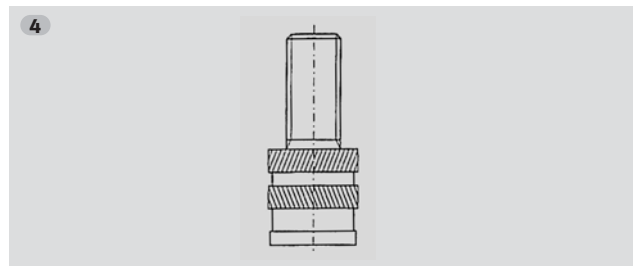
The three elements of an ultrasonic metal insert



Standard threaded insert



Threaded insert with flange



Insert with set screw

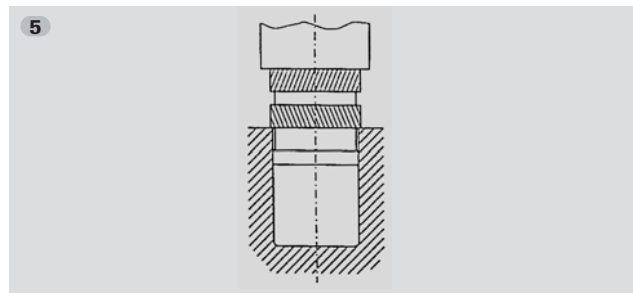
This requirement can be adhered to very easily by using inserts with a flange, and taking appropriate measurements. Also the tendency to protruding flash is significantly less because the flange forms a barrier against the rising molten material.

If shafts, axles or other unfavourably shaped parts have to be inserted, it is advisable to locate the metal part inside the fixture, and allow the ultrasonic energy to act upon the plastic part. The points in the **Construction Guidelines for Ultrasonic Welding** described under near and far field welding must also be taken into account. Marking must be expected on the coupling surface. By using a protective foil between the sonotrode and the plastic part, this can be avoided.

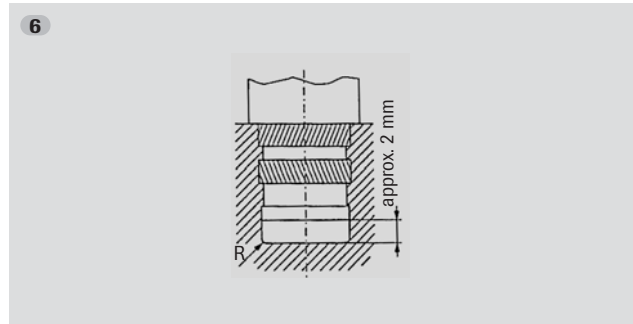
Notes

Sonotrodes are subject to a high rate of wear and tear by the metal-to-metal contact when inserting is done. For this reason the sonotrode tips are either treated with a coating of hard material or manufactured from hardened steel. Any repair work on worn sonotrodes should in principle be left to the manufacturer. Abrasion of metal must be expected at the inserting points. To avoid damaging threads when inserting is taking place, they should have a suitable counter-bore. Information regarding the dimensions of the counter-bore hole can be obtained from the ultrasonic insert manufacturer's corresponding documentation. We will gladly supply you with the address of these companies on request.

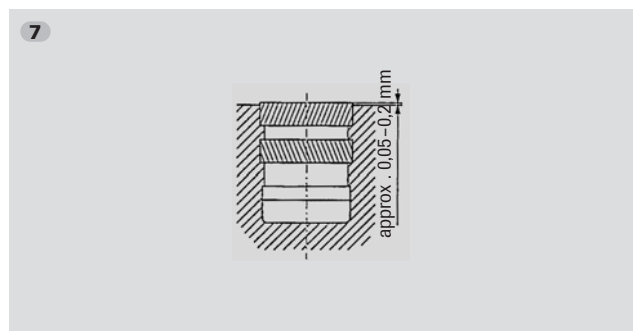
Thermoplastic joints can also be produced by ultrasonic inserting. Inserts made of thermoplastics with higher melting points and of lower deformability than the surrounding material can be processed very well. The options extend to joints made from the same material. Here, however, special measures are needed for design. We strongly recommend that you use the support available from RINCO ULTRASONICS AG, Application Technology.



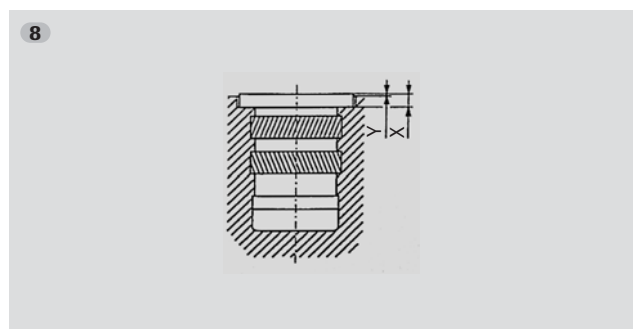
The insert is inserted and precentred over the reference diameter.



The insert is pushed in by ultrasonics and firmly encased in the molten plastic.



Insert Protruding Slightly



Insert with Flange. Dimension X determines residue Y.

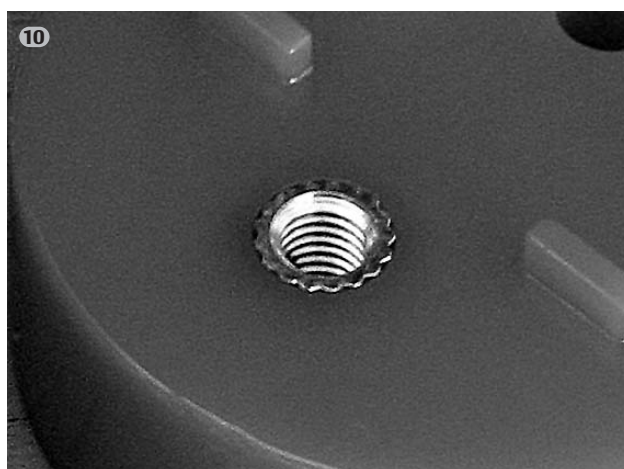
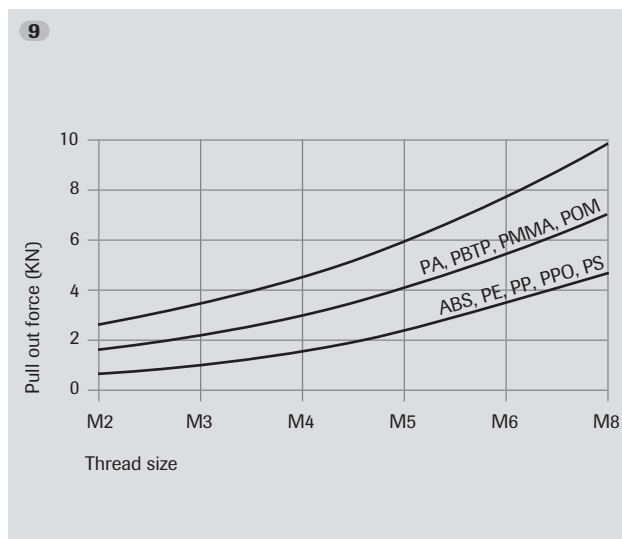
Noise Protection 9

The excitement of a metal part by ultrasonics generally leads to development of a high noise level. With 20 KHz systems the frequency level of this noise is within the audible range. The strength may reach levels which can damage hearing. The use of hearing protection devices is strongly recommended. The neatest solution is provided by acoustic booths, which incorporate the complete ultrasonic welding machine. Such booths are of course a part of the RINCO ULTRASONICS AG product range.

The table at the side shows the standard values for the pull out forces of inserts. When filled materials are used (glass fibres, minerals, etc.), the values are generally speaking higher still. They are significantly influenced by the processing conditions, and may deviate upwards or downwards accordingly.

10 An exceptional application:

Six metal threaded inserts are inserted in a working cycle.



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