COMMON PROBLEMS ASSOCIATED WITH HAND OR BATCH MIXING TWO PART POLYURETHANE FOAM

The following is a collection of several of the most common problems arising from the mixing of two part Polyurethane systems. Whilst it is not always possible to achieve absolutely perfect foaming conditions, a repeatable satisfactory result can be arrived at by bearing the following points in mind.

INCORRECT TEMPERATURES

Polyurethane chemicals are temperature sensitive in that the viscosities of the two components vary significantly in the range 5-30^{0}C and the reaction rate is dramatically affected. Chemicals below 15^{0}C will be significantly more viscous than above, and this will translate into a much greater difficulty in mixing the components sufficiently well. Temperatures much above 22^{0}C will speed up the reaction enough to make foaming difficult. The recommended temperature range will be given in the technical information, but will probably be 18-22^{0}C. The surface contact temperature of the material the foam is reacting against is also very important, it is no good warming the chemicals to the correct temperature and then pouring them into a very cold cavity, for example. As a general rule the contact temperatures should be at least 20^{0}C more if the thermal mass of the object which is being foamed is high..

INCORRECT RATIO

Two component Polyurethane systems require that the materials are mixed in the correct ratio, usually expressed in the terms of weight, and given in the technical information. It is important to understand that it is not a case of one component being a curing agent or catalyst and therefore being variable. An excess of the Polyol component will give a soft feeling foam, often light and fine celled in appearance, which will probably shrink in time. An excess of Isocyanate will give hard feeling foam, often dark and coarse celled, which will be more brittle and less resilient than foam made at the correct ratio. Weighing is much easier to do accurately than measuring by volume, but it is vitally important that what is actually mixed together is the correct ratio, rather than what is initially measured out. This means that where one component is poured into another, allowance must be made for the amount left in the container that it was poured from, it is much better to weigh one component directly into the other on the scales.

The relevant quantities to be weighed out to give the correct ratio can be calculated as follows. For a system with a ratio (A:B) of 1:1.2 by weight, where a total weight of 2,700 grams is required:-

Quantity of A required = (total weight divided by total of ratios) multiplied by A ratio.

i.e. 2,700 divided by 2.2 multiplied by 1

= 1,227 grams.

Quantity of B required = weight of A multiplied by B ratio.

i.e. 1,227 multiplied by 1.2

= 1,473 grams.

A final check is to make sure that the two quantities add up to the required total amount.

CONTAMINATION

Both components are affected by atmospheric moisture. The Isocyanate component reacts slowly to give a hard plastic product and Carbon Dioxide gas, the hard product is the “skin” which forms on Isocyanate left open to atmosphere. The Polyol component absorbs water vapour very quickly, but shows no visible difference, however, when the two components are mixed the water reacts with the Isocyanate component to give Carbon Dioxide gas and a plastic called urea. The Carbon Dioxide gas blows the foam to give a lower density than specified for the system, and the Isocyanate which has reacted with the water is not available for reaction with the Polyol component, resulting in a foam which is under density and short of Isocyanate, both of which will give unstable foam.

Various other contaminants will give difficulties, for example, oils or excessive wax type release agents will cause cellular collapse, and foam which is reacted against insufficiently cured fibreglass will have a weak "furry" layer caused by the free styrene in the surface of the fibreglass.

CORRECT DENSITY

Most Polyurethane systems are not designed to be allowed to react totally "free rise", i.e. usually they should be subject to a certain amount of restraint to give the required density throughout the foam and particularly to avoid the "stretching" of the foam cells which can occur in free rise foams. The required density will vary from system to system, and for any given system a relatively small thin moulding with a lot of surface area will require a much higher density than a large compact moulding. Generally once the required amount for a particular moulding has been decided upon, it should be adhered to, with only slight variations to accommodate extremes of ambient temperature.
It should also be remembered that the reaction is an exothermic one, and that there can be a considerable build up of heat immediately after the foam has reacted. Given their insulating nature, low density foams in particular can be much hotter in the core of the mass than the surface suggests, quantities as low as 80 grams can give a temperature in excess of 140°C in the centre. This high temperature will obviously give a dimensional change to the foam as it is lost, and uneven contraction due to this temperature loss can only be combated by "overpacking" the moulding sufficiently well. Overpack rates will usually be at least 15-20%, i.e. the overall density of the finished moulding will be at least 15% higher than the nominal free rise density of the system.

EFFICIENT MIXING

Generally the more efficient and forceful the mixing, the better the quality of foam. A guideline to the time available will be given in the technical data, the cream time is the time from the start of mixing to the point at which the foam starts to react and rise. This time will vary depending on temperatures, efficiency of mixing and the total amount mixed, but it is best to have mixed the foam and poured it into the cavity to be filled before it is rising significantly. It is best to mix air into the Polyol component before mixing the two components together, and as a guideline if the mixing method in use can significantly aerate the Polyol component in the mixing time to be used to mix the two components, then it is sufficient, anything less will not give the best results. A propeller type agitator in a high speed air or electric drill is usually suitable for quantities up to 20kg.

POURING METHOD

As soon as the foam is sufficiently well mixed it should be poured into the cavity to be filled. Obviously this must be done as quickly as possible, ensuring that all foam is poured, and can reach the bottom of the cavity, before any significant amount of rise. If the materials must be weighed out a small distance away from the pouring position, then it is preferable to carry the unmixed components to a position as close as possible to the pouring point before starting mixing.

It is also vitally important that the foam is placed in the correct position in the cavity, the ideal scenario is for the liquid foam to start rising from the bottom of the cavity, pushing the displaced air in front of it towards a breather point at the highest point in the cavity. Whilst it is not often possible to realise this ideal completely it is important to ensure that the foam can push all of the air out of the cavity through suitably sited breathers.

FOAM MIXING

1. IS THIS THE CORRECT SYSTEM FOR THIS JOB?

2. ARE THE VESSELS TO BE USED CLEAN AND DRY?

3. HAVE THE CHEMICALS BEEN KEPT SEALED FROM MOISTURE?

4. IS THE AMOUNT REQUIRED FOR THIS JOB KNOWN, AND CAN THE AMOUNTS BE MEASURED SUFFICIENTLY ACCURATELY? REMEMBER IT IS THE AMOUNTS WHICH ARE MIXED TOGETHER WHICH ARE IMPORTANT.

5. ARE CHEMICALS AT THE RIGHT TEMPERATURE? 18-22^{0}C IS MOST SUITABLE, 16-24^{0}C MAY BE USABLE.

6. DOES THE MIXING METHOD TO BE USED GIVE A SUFFICIENTLY GOOD MIX LEAVING ENOUGH TIME TO POUR THE FOAM BEFORE IT RISES SIGNIFICANTLY?

7. IS THE CAVITY FREE FROM CONTAMINATION (RELEASE, OIL, WATER ETC), AND IS THE FIBREGLASS PROPERLY CURED?

8. REMEMBER TO PREMIX AIR INTO COMPONENT A.

9. ENSURE RISING FOAM WILL NOT TRAP AIR IN CAVITY, BREATHER MUST BE LARGE ENOUGH TO ALLOW AIR OUT BUT NOT ALLOW EXCESSIVE FOAM LEAKAGE WHICH WILL RESULT IN LOW FOAM DENSITY.

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