Foundry Products: Technical Data Sheet

***Process Overview: Chemistry and Use Of* Rapidur Binders™**

Technical Data

PHENOLIC-URETHANE NO-BAKE SYSTEMS

INTRODUCTION

The phenolic-urethane no-bake system is a three part binder which offers an alternative to gas cured systems for the high speed production of moulds and cores.

This system is based on a phenolic based resin and a polyisocyanate component which are cured by using a liquid catalyst. Various solvents are used in all these components. The components are capable of producing strippable cores and moulds as fast as 30 seconds up to many minutes, depending on the type and concentration of catalyst used.

The unique feature of the system is the curing reaction itself. Basically there is a delay in the curing reaction after the three components are mixed with the sand. This delay is the “working time” of the mix and enables the sand mix to remain free flowing until the curing reaction begins.

APPLICATION OF THE SYSTEM

The system can be mixed in most foundry batch mullers, auger type continuous mixers and high speed intensive mixers. The mixture is flowable, but some form of compaction is recommended. The fast reaction rate of the system requires well maintained pattern equipment as the system becomes very rigid on stripping and does not easily yield. Depending on catalyst chemistry, strip times are less sensitive to sand type, temperature, moisture, additives and impurities than some acid catalyzed binders. The catalyst type, concentration, addition rate and sand temperature control the reaction rate. A sand heater/cooler is not a prerequisite for operation, but should be seriously considered as an aid to maintaining a constant strip time. The type and temperature of the pattern material can also affect the strip time of the system.

Usually, the chemical reaction of the system reaches about 80% completion in approximately 4 hours. Depending on the metal poured and foundry practice, the system can be poured on in as little as an hour after moulding. In general, however, three to four hours should elapse prior to pouring, especially if the mix is cold. Bond strength of cores and moulds will not deteriorate on prolonged storage.

System hot strength is excellent, shakeout is good and the sand is reclaimable.

All metal types can be moulded with this system.

THE CHEMISTRY OF THE SYSTEM

The system consists of three parts:

Part 1 or A is a phenolic resin in various organic solvents

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Part 2 or B is a polymeric isocyanate rein in various organic solvents.

Part 3 or C is usually a liquid amine or amine donor type, which is optionally in various organic solvents.

Total binder level is based on the weight of the sand and is usually in the range of 0.7 to 2.0%. In general it is recommended that the part 1 to part 2 ratio should range from 50/50 to 55/45, added to reach the desired binder level. If the castings to be pored are sensitive to gas defects, such as pulleys, flywheels or cylinder heads, consideration should be given to altering the ratio to 60/40.

Catalyst usage is generally 0.4 to 10% of the weight of part 1, depending on the catalyst concentration, catalyst chemistry, strip time desired, sand type and sand temperature.

HANDLING AND STORAGE

The part 1 resin has a relatively limited storage life and can continue to polymerize, (or thicken), if stored at high temperatures. Generally, the shelf life of the resin in tightly sealed containers is at least 6 months if stored below 90°F.

The part 2 component is a polymeric isocyanate which will react with water to form a urethane polymer and carbon dioxide gas as a by-product. It is recommended that this product not be stored outside or in direct sunlight as water could build up on the drum top which during storage heating/cooling could be aspirated into the drum through the seams or bung. If it must be stored outside, the material should be tightly covered with a waterproof tarpaulin. Further, drums that are stored in direct sunlight can reach temperatures of 150°F or more. This could cause a pressure buildup, loss of reactivity and an increase in viscosity. If stored in bulk, a Nitrogen or absolutely dry air blanket must cover the surface. All material handling equipment should preferably of stainless steel or an alloy compatible with the chemical ingredients.

The part 3 catalyst component should be stored in tightly sealed containers. The anticipated shelf life will be up to one year if stored below 90°F.

PARAMETERS AFFECTING PERFORMANCE

SAND TYPE:

Round grain silica sand yields optimum performance properties with this binder system. Specialty sands, including Zircon and Chromite, are compatible, as are most subangular lake and bank sands. Acid impurities tend to slow setup, while basic contaminants may accelerate the cure. A grain fineness number of from 50 to 80 is recommended, with a minimum of fines.

SAND TEMPERATURE

Whilst the ideal sand temperature for the system is 80 to 90°F ,(27-32°C), sand as cool as 60°F, (16°C), or as warm as 100°F, (38°C), is usable. The main concern should be to maintain a consistent sand temperature, not varying more than plus or minus 5°F (3°C). This

will yield consistent and predictable cure speeds and will minimize the need to adjust catalyst levels during production.

The reaction rate can be accelerated by raising the sand temperature and/or the catalyst level. Adding more part 2 has little effect on increasing the reaction rate and should not be used to try to control strip time. Sand heaters are recommended when sand temperatures fall below 60°F or varies abruptly, i.e., 15°F/hour. If the sand temperature cannot be controlled from winter to summer, then it may be necessary to use two types of catalyst, which vary in active ingredient concentration. When the sand temperature drops too low the reaction rate may become so slow that additional catalyst will not significantly decrease the extended strip time. Conversely, at high sand temperatures, the reaction rate becomes so rapid that it can result in preset sand and low tensile strengths which will lead to erosion and penetration type defects.

MOISTURE

Moisture in the base sand will retard the chemical reaction from proceeding to completion. The moisture content should be kept below 0.25% to minimize this effect.

ADDITIVES

Additives can be used to correct casting defects. Both red and black Iron Oxide are the most common additives, mainly used to reduce gas defects in steel castings. They also help to eliminate expansion defects and reduce lustrous carbon defects. Depending on the type of oxide used, the binder level is usually increased by 0.1 to 0.2%

Venting should be increased when additives are used as the permeability of the sand mass will be decreased. It is recommended that quarter inch vents be placed within 1 inch of the pattern surface at 9 to 12 inch centers to allow the decomposition gases to escape to the atmosphere. The vents should be lit off on pouring to promote the flow of the gas from the mould cavity.

MIXING

The system can be mixed in most foundry batch type mullers, auger type continuous mixers and high speed intensive mixers. Part 1 and the appropriate catalyst are added to the sand first. Due to the low levels of catalyst used care should be taken to ensure that it is efficiently distributed to ensure that the system performs optimally.

Mixing times for batch mixers are best determined at the point of use: overmixing of sand and resin may result in lower tensiles, due to partial curing of the mix; undermixing may result in poor distribution and lower tensiles.

Proper mixing will discharge as a free flowing mass that can be distributed and compacted easily, as essentially there is no green strength.

CURING SPEED

The cure speed of the mixture is dependent on the percentage and type of catalyst, sand/ambient pattern temperature, acid demand value and moisture content. The catalyst percentage used enables the foundry to adjust the working time/strip time ratio from

approximately 30 seconds to many minutes, with the working time being approximately 75% of the strip time.

The unique nature of the system is the curing reaction. Basically, there is a delay in the curing reaction after the three components are mixed with the sand. This delay is the “working time” of the mix and enables the sand mix to remain free flowing until the curing reaction begins.

Once the reaction starts, it is extremely rapid and thorough. Because the crosslinking reaction does not evolve side products, the curing rate is constant throughout the entire sand mass. There is no prolonged plastic stage during the cure nor are there soft spots after the cure has been completed. Two thirds of the system’s ultimate strength is attained after about 4 hours and ultimate strengths are achieved at 6 to 12 hours after strip.

Since the curing reaction resulting in a strippable core or mould occurs so rapidly, high production rates and rapid equipment turnover is possible.

PATTERN EQUIPMENT

Patterns may be constructed of wood, plastic or metal. Patterns should be clean and as free of scars or undercuts as possible to permit easy stripping of the core/mould. When metal patterns are used, they should be maintained within 10 degrees of the sand temperature or striping problems could occur due to uncured or overcured sand at the pattern interface.

When plastic tooling is used, the compatibility of the pattern material, the release agents and cleaners used, with the resin system should be considered. In some cases, blasting with walnut shell or fine sand may be preferred to solvent cleaning.

EQUIPMENT

Due to the favorable work time/strip time ratio of the system, high core/mould production rates and equipment turnover are possible, especially when automated loop or turntable equipment is used. Depending on the surface condition of the pattern/core box, the release agent used, and the pattern draft, small and shallow moulds or cores can be stripped at a much faster rate than tall or large sand configurations.

To obtain the greatest productivity with the system, particular attention should be paid to the stripping of the core/mould. When proper attention is paid to the strip time interval and the condition of the patterns, stripping is easily accomplished. If, however, the sand mass is allowed to remain in the pattern after the logical strip time, or if the patterns are rough due to sand/binder buildup or to general wear and tear, core/mould stripping may be more difficult. While release agents may help such a problem, there is no substitutes for monitoring the strip time closely and maintaining the equipment properly.

COATINGS RECOMMENDATIONS

A refractory coating is optional, depending on alloy poured, casting configuration and metal section. If a coating is required, any of the conventional coatings and application procedures appropriate to the alloy poured can be used. With any such coating, it is essential that the solvent carrier is completely evaporated before pouring metal.

It is best to apply a water based coating immediately after stripping if it is also dried immediately. With alcohol based coatings, it is best to wait a minimum of 10 to 20 minutes before coating. These coatings should be lit off immediately after application.

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ADHESIVES

Conventional adhesives or core glues, both hot and cold, can be used to fasten loose cores and to secure mould halves. In certain instances where tongue and groove or male/female type locators are used in mould halves and sufficient clamping force is applied, moulds are being poured successfully without parting line adhesives.

HUMIDITY

High humidity will tend to slow down the initial reaction by tying up the part 2. High humidity will also tend to decrease the strength of the bond.

POURING TIME

It is recommended that pouring take place at least four hours after strip time. However, in specific cases, shorter pour times are practiced. In general. The shorter the strip time, the shorter the wait to pour. Steel and iron castings have been successfully poured in less than 30 minutes from stripping.

METALS

This system is being used in the casting of gray and ductile iron, alloy steel, an nonferrous metals. In steel applications, the use of 2 to 3% iron oxide based on sand weight may be required for optimum casting finish through the elimination or reduction of surface porosity and lustrous carbon defects.

RECLAMATION

The bonded sands are readily reusable through reclamation by either mechanical or thermal procedures. Care should be exercised to ensure efficient binder removal, as measured by LOI tests. The preferred LOI should be below 2%, as higher LOI levels can result in greater gas evolution, higher binder demand and reduced tensile strength development.

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