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Mass Production Pre-Mixed Clays

Purchasing pre-mixed moist clay from a ceramics supplier can offer many choices in terms of firing range, kiln atmosphere, forming characteristics and fired color. By offering a wide range of moist clays the ceramics supplier is hoping for a satisfied customer who will be buying more clay in the future and possibly other supplies and equipment. A supplier can place a great amount of effort in the planning and testing of a pre-mixed clay before it is ready for sale. However, many stock clay body formulas were originally an individual potter’s clay body that the supplier is now mass producing, hopefully with the potter's consent. Sometimes if a clay body works well for one person and is formulated correctly all is well, and many potters use it with good results. The formula gains popularity and stays in the catalog.

Whether a clay body formula comes into existence by this method or is developed in house and tested before committing to full production, there are several market, economic and technical matters that have to be considered.

Market Demand Factors

Ceramics suppliers can conduct an informal survey of potters just by asking what kind of pottery or sculpture they are producing at various temperatures in what kiln atmospheres. They can then devise clay bodies to suit the needs of their customers. If the ceramics supplier's market contains a great many schools, an inexpensive, low temperature clay body that fits a wide range of commercial glazes might be required. This type of clay body can be composed of relatively low cost ball clays and fillers such as talc to meet the competitive bid structure of

many school districts. If potters are making functional stoneware pottery, a mid range to high temperature white or brown clay body suitable for wheel or hand building might satisfy the market. Higher priced clays such as fireclays or stoneware clays which are designed for salt, soda, Raku or wood firing might require specialized raw materials designed to enhance the effects of fast firing or vapor kiln atmospheres. Production runs will vary, depending on the specific clay body. It is always more efficient and profitable to produce a long run of a clay formula as opposed to having to clean machinery between new formulas.

A major consideration for adding a new moist clay to the catalog is not duplicating an existing clay body. There is no economic sense in copying a clay that customers are already buying. An exception is when a competing supplier has a popular moist clay, and the competition must be met to hold or

increase market share. While new moist clay formulas do come about, most ceramics suppliers have a vested interest in keeping their existing formulas as potters generally stay with a clay that is producing consistently good results.

National or local advertising through magazines, catalogs or websites is frequently accompanied by color images of the different clay bodies along with their recommended firing temperatures and color in reduction and oxidation kiln atmospheres. A short description of the clay body and its potential uses is also listed along with pricing at various amounts plus delivery charges. Since the transportation costs of moist clay to the potter can be significant most potters order from local or regional sources, either through the ceramics supplier who mixes clay or their distributors. In the past few years professional potters' testimonials have been used to promote sales.

Moist clay name and description

Moist clay is usually named or numbered depending on the history of the ceramics supply company's method for clay body designations. However, each clay body does have a catalog number for easy and accurate ordering and tracking. When choosing the name or number it is often a matter of personal preference. Some clays are named after the person who developed the formula, such as Pete's Supreme, or it can be a purely generic and numerically descriptive designation such as White Stoneware with grog #3333.

Technical Factors - Clay body performance

A clay body formula must be all things to everyone and still have a specific character that the potter can recognize and want to purchase again. After all, why buy one over another if they all are the same? The clay body must have good handling and firing qualities for a wide range of potters with varying degrees of skill, which is often a difficult balance to achieve. Clay bodies could be formulated that would be “cutting edge” in performance but such extremes would not make them profitable to produce as only a few skilled potters could enjoy the results.

One of the most common customer complaints is the moist clay's consistency. One potter might find the clay too hard while another states the same clay is too soft. Often the difference between hard and soft clay is a 5% to 6% variation in the amount of water used to

mix a specific batch. Ceramics supply companies have instituted several quality control measures to ensure consistent moisture content in each batch. One device is the penatrometer, a needle-like instrument that when pushed into moist clay registers its resistance. With soft clay, the needle sinks in; harder clay with less water in the batch presents greater resistance to the needle, all of which is quantified by numbers on the device.

Ceramics suppliers also keep accurate tallies on the amount of dry material and water used when mixing clay. Interestingly, the water content can change considerably from one clay formula to another, ranging from 18% to 30%. Clay bodies for throwing that contain high amounts of ball clays will require more water to achieve plasticity than sculpture bodies containing grog and larger platelet clays such as stoneware or fireclays.

The water content can also vary with the same formula from batch to batch. Most clays are air floated and have a small amount of moisture in them from the mines. The moisture content from one lot to another can make a slight difference in the final water content added to the mix. A quart of water added or subtracted from a 1,000 lb. batch of clay can make a significant difference in handling qualities of the plastic clay. Most commercially produced moist clays range from 19% - very stiff clay - to 30% moisture content, resulting in a very soft clay body. Potters requiring a specific consistency can send a carefully wrapped sample of moist clay to ensure the correct moisture content in the larger batch mixed at the ceramic supplier's.

In order to track the many variable clay mixing factors a well trained, highly experienced crew is essential. One major ceramics suppler states, “it takes a year to fully instruct a clay mixing operator and five

years to train a pug mill operator." Paying minimum wage workers to mix clay can produce poor quality control. Also, low pay can mean high turnover rates in personnel, all of which affect moist clay consistency. In the long run, it pays to invest in a fully trained staff that can work with the variable nature of the material and mixing factors.

Aside from the careful monitoring of the water content for each clay body, many ceramics suppliers place problem clays such as fireclay through a 30 to 100 mesh screen. They also use rare earth magnet iron filters to reduce unwanted iron specking in the clays. The clay mixing water is also tested, as hard water containing calcium or magnesium minerals can flocculate or harden the moist clay. Soft water with sodium mineral deposits can deflocculate the clay, causing a soft, easily deformed plastic mass when subjected to forming methods.

Firing range

As a general rule a single clay formula cannot do everything, and that's why there are so many different pre-mixed clays available. Adequately formulated clay bodies should have a firing range of 3 pyrometric cones. For example, if a clay is rated as c/9 it should function at cone 8, 9 and 10, without deformation and excessive shrinkage. Be on guard if a moist clay has a wide firing range as it might not be dense and vitreous over its entire range. While high temperature stoneware clay bodies can be used for low temperature pit firing or Raku firing due to their open porous structure at low temperature, clays can deform and melt if fired to high temperature. Most ceramics suppliers offer a range of clays at c/06 (1828 ^{0} F.), c/6 (2232 ^{0} F.) and c/9 (2300 ^{0} F.).

Ceramics suppliers list the shrinkage and absorption rates for each moist clay they sell. The percentages are useful in comparing one clay with another, but there can be a plus or minus of 1% or greater difference in how much the clay will shrink or absorb moisture in your own kiln. The published numbers should only be compared with other clays listed in the catalog in a very general way. Comparing these numbers is even more imprecise as the size of the test kiln and the firing time to temperature are variables that can make comparisons meaningless. To arrive at precise shrinkage and absorption rates fire the moist clay in your own production kiln, as small test kilns have different firing and cooling rates than larger kilns.

Forming method

Clay bodies are formulated for throwing, hand building, jiggering, Ram pressing or slip

casting. Each requires a different ratio of plastic to non plastic materials in addition to fluxes and fillers. Various clay types such as fireclay, stoneware clay, earthenware, kaolin, ball clay or bentonite are frequently combined to impart specific characteristics to the clay body. Throwing bodies require the most plasticity, which is derived primarily from ball clays, bentonite and other plastic clays. Hand building, jiggering and Ram press bodies have greater percentages of non plastic clays such as fireclay, kaolins, and stoneware clays and higher percentages of non plastic materials such as flint, feldspar and pyrophyllite. It is not unusual to use a throwing body for hand building in some ceramic projects. However, the larger or thicker the hand built piece the more specialized the clay body requirement. Casting slips are a world unto themselves and are much more sensitive to the exact ratios of water, clay, filler, flux and deflocculant.

Kiln atmosphere

Whether the moist clay is fired in an oxidation atmosphere (excess air to fuel ratio in combustion), neutral atmosphere (equal amounts of air and fuel) or reduction atmosphere (excess fuel to air ratios) the clay body formula will have to be compatible with the firing kiln's atmosphere. Generally, clay bodies designed for reduction kiln atmospheres can also be fired in neutral or oxidation due to possibly high amounts of iron oxide or iron bearing clays in the clay body not being over fluxed by the neutral or oxidation atmosphere. However, depending on the specific formula, the clay bodies might not look the same. Conversely, clay bodies designed for oxidation atmospheres can possibly be over fluxed in reduction kiln atmospheres due to their high iron content. Ceramics suppliers should indicate the atmosphere recommendations for each clay body they sell.

Clay bodies can also be developed for wood, salt, soda or Raku firing. The wood kiln presents several elements not found in other types of atmospheres. Stoking can create intermittent oxidation, neutral and reduction kiln atmospheres, all of which can create random flashing on the exposed clay surface. At temperatures above 2300 ^{0} F. wood ash begins to flux into an alkaline glaze, altering unglazed and previously glazed clay surfaces. The clay body must accommodate such wide ranges of atmosphere and variations in wood ash deposits.

In salt and soda firing, a sodium vapor atmosphere is introduced into the kiln and reacts with alumina and silica in the exposed clay body surfaces, creating a sodium/alumina/silicate glaze. The clay body must be formulated to develop an “orange peel” or gloss surface. In some instances, random flashing of the surface is desired, and

the clay body should accommodate this reaction.

Raku clay bodies must be able to withstand wide ranges of heating and cooling in either an oxidation or reduction carbon trap atmosphere, all within a short period of time. Additionally, the clay body must accommodate a broad range of fast fired glazes.

Fired color

Ceramics suppliers try to offer a wide range of clay body colors in different temperature ranges. Dark brown, brown, light tan and cream are often the easiest and least expensive colors to produce as they depend to varying degrees on iron bearing clays. Porcelain or white stoneware clay body formulas which require imported or domestic kaolins and are more difficult to develop average a few cents more per pound than ball clays or stoneware

clays. Black, green or blue clay body formulas require a higher level of expense depending on the coloring oxides or stains used.

Moist clays' stability in storage

Many ceramics suppliers ship their moist clay in two 25 lb. 3 mil plastic bags which are enclosed in a cardboard box. The bags are sealed either with a twist tie, rubber band or a cost cutting twist of the plastic bag as it is placed in the box. The name of the manufacturer and clay name or catalog number are usually stamped on the box. Since the plastic bags are permeable the average shelf life of the moist clay is 4 to 6 months before it becomes harder. Some ceramics suppliers use a thinner 2 mil bag because it seals more effectively than a thicker bag, but it leaves the moist clay more prone to air infiltration.

Moist clays in the plastic bag can become harder or softer due to the breakdown of soluble materials such as nepheline syenite, which can make the moist clay softer with age. Conversely, some frits and Vee Gum T can have the opposite effect, causing the moist clay to become harder in the plastic bag. The pH content of the clay mixing water - whether acidic or alkaline - can also intensify the effects of raw material solubility, creating harder or softer clay in the bag. Generally, clay bodies containing high percentages of ball clays remain softer longer in the plastic bags, as a greater percentage of water film surrounds each clay platelet. Coarser clays with less surface area require less water for plasticity and dry out somewhat faster in the bag.

Raw material substitutions

Periodically, a ceramics supplier will have to reformulate a clay body due to one or more of its raw materials being discontinued. In some instances the ceramics supplier does not have the mechanism for notifying each customer. Many will note a change of raw material on their websites or when a customer calls to re-order, and ceramics suppliers who wholesale their clay send letters to their distributors. If a substitution is successful the customer's moist clay will have the same handling, glaze fit and firing characteristics as their original clay body formula.

Economic Factors

Some ceramics suppliers mix and sell their own moist clays. Others buy moist clay at wholesale and sell it to their retail customers. Raw material costs have increased, primarily

due to increases in transportation. The machinery used to dig and process clay runs on diesel and gas fuel. Carriers have instituted fuel surcharges as have material suppliers and mines. At some point these costs have to be passed on and factored in to the retail pricing of the moist clay.

While ceramics suppliers try to use domestic clays and raw materials whenever possible there are some materials that have to be imported, such as spodumene, Grolleg and English China clay. The same domestic transportation fuel surcharges apply getting the materials from the point of entry into the United States to the ceramics supplier's mixing facility. The materials are also affected by currency fluctuations. Imported clays and raw materials also tie up the importers' capital as shipments can take months to reach the United States.

The average profit margin on ceramics suppliers' moist clay is 30% to 35%, which does not allow for inefficiency in the ordering, mixing and shipping. Other items such as tools, pottery wheels, kilns and related goods have higher profit margins and contribute more income than moist clay sales. The retail price of the moist clay is also a central factor as it compares to the competition. Many potters consider the price of moist clay in their purchasing decisions. They are reluctant to pay a few cents more per pound, thinking they are saving money while not realizing it is the quality of the clay and the expertise to mix it that is most important. Why save pennies on a pound of poorly mixed clay and lose dollars in pottery sales due to defects in the clay? Yet many potters fall into this trap only to discover that cheap clay can turn out to be very expensive when it fails in the forming or firing process.

However, a ceramics supplier has to be aware of pricing their moist clay in relation to the competition, as many potters still shop only by price and do not factor in the actual quality of the moist clay. A supplier's large stock of dry and moist clays make for efficient customer service but carries a cost that cannot be directly passed on to the customer. For ceramics suppliers the economics of making moist clay or buying it from a distributor are major factors, as the correct choice will keep the business viable.

Aside from low raw material shipping costs, ceramics suppliers are looking for clay body formulas that are easy to produce and have the widest appeal. A long production run of a single clay body formula is the ideal situation for a supplier, preferably followed by a formula of the same temperature range in a similar color. Any deviation such as a different temperature range or fired color can slow down production as more time is needed

to clean equipment between runs. Nylon, fiberglass and paper fibers and additives can achieve unique results in a clay body but can also increase clean outs of mixers and pug mills, all of which mean increased labor costs and higher moist clay pricing. The same production considerations apply to the use of coloring oxides or stains in the clay body. If the machines are not cleaned properly the next batch is contaminated. A small amount of iron oxide or iron bearing clay can contaminate a batch of white clay, which is often unnoticed until the clay is fired.

Cost vs. Performance

As in any production situation there is always the balance between creating exceptional performance in a clay body - low shrinkage, good handling properties, correct glaze fit - and little or no deformation in firing. However, does the cost to bring these qualities

and value added features justify the higher price that must be charged? For example, different particle size clays and raw materials can be used in a clay body to densely pack the moist clay, resulting in better handling qualities. The best clay body formulas have small, medium and large structures, either in the form of clays and raw materials, but that might mean adding two or more ball clays or multiple fireclays of different particle sizes, all of which results in higher costs.

Filter pressing, a labor intensive and slow process, can also be employed. The clay is slaked down with water, and the resulting slip is run through an absorbent leaf-like structure to remove excess water. This method thoroughly surrounds each clay platelet with a water film, increasing its plastic properties, which adds cost to the final moist clay. Will there be enough potters willing to purchase a clay body engineered and processed to such a degree? Such production questions have to be

calculated by the ceramics supplier and balanced with what the market will buy.

Raw material availability

Rising fuel prices can yield transportation charges equal to or exceeding the actual cost of the raw materials, making it uneconomical to use distinctive clays from a distant location to achieve unique handling or firing qualities in a clay body. There is always a risk that only a few potters will choose to buy such a specialized formula. Ceramics suppliers tend to choose raw materials that will remain in production for reasonably long periods. However; there is no guarantee of perpetual raw material availability in clay body production.

For example, NYTAL HR 100 talc was discontinued in January, 2009. The talc was mined in New York State and was used in low

fire white clay body formulas for years. For some east coast ceramics suppliers the freight cost to substitute Texas talc has substantially increased their cost. Consequently, suppliers have passed on the increase to their customers. At some point any given raw material may be discontinued which might affect overall pricing to the moist clay.

Raw material quality

Clays are mined and refined to the specifications of larger industry standards which might not ensure their problem-free use by potters. The percentage of defects based on the million of pounds of moist clay produced is exceptionally low. However, even one defect has a disproportional effect, because of the time and labor lost.

Very few ceramic suppliers will take the additional steps of refining clays further to ensure better quality moist clays for their customers. A few do screen their clay, but this extra step adds to the cost due to the equipment, labor and time involved. Some segments of the market are willing to pay the extra cost for improved quality moist clay as the screened clays run a few cents more per pound.

Aside from screening, ceramics suppliers are reluctant to use additives such as Epsom salts, bentonite, nylon fibers, fiberglass fibers, paper pulp or Additive A in their stock clay body formulas due to the limited number of potters willing to pay for the added costs of the materials, machinery cleaning and the time required to fit the special clay body into the production cycle.