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ADDITIVE FOR FOUNDRY MOLDING SAND

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This invention relates to foundry molding sand and more particularly to additives for improving the operation of reclaimed sand mixes.

As prepared, a typical new foundry molding sand mix will comprise a mixture of sand, clay, water, and a carbonaceous material which is usually a finely ground soft coal such as a coking type of bituminous coal, known in the industry as "seacoal," but which may comprise, for example, pulverized anthracite, low-volatile pocahontas or high volatile types of midwestern coals. Other carbonaceous materials are sometimes also aded. A representative specific composition of a typical new sand mix might be 92% by weight sand, 6% clay, 2% seacoal, plus sufficient water to plasticize the clays and make a workable molding material.

Seacoal, or its equivalent, is used in the mixture because of the desirable effects it has on the interface between the cast hot metal and the mold. It is generally thought that the heat of the molten metal as it enters the mold acts upon the seacoal to release volatiles from the coal which create a reducing atmosphere in the mold cavity, and that these volatile gases tend to recondense within the sand immediately behind the mold-metal interface, and impart to the sand the property of "hot deformation," whereby the sand can deform slightly without rupturing from the expansion and internal stresses caused by the sudden heat transfer from the molten metal. In addition, the seacoal causes the sand to "peel" or release from the casting so that the casting has a relatively smooth finish, rather than a rough finish with included or adherent sand on its surface.

Because of the cost of materials, it is common practice in the foundry industry to reuse molding sand mixes As is well known in the industry, the used mix must first be "rebonded" or reconstituted with additional seacoal, or its equivalent, and clay, even though it contains clay and seacoal from the initial formulation. Over a period of years, experience has shown that the total amount of seacoal required in rebonded used mixes is much greater than the amount required in a new mix to give the proper reducing atmosphere and to produce the proper "peel" or sharp separation of the sand from the surface of the casting. Thus, a typical rebonded mix might comprise 98½% used sand mix (which itself contains used seacoal and used clay), ½% new clay, and 1% new seacoal.

The reason that additional seacoal is required in rebonding a used sand is that apparently in use some of the original coal volatiles are lost or somehow become "locked in" or "oxidized" in the coal, with the effect that used coal is rendered much less effective than new coal. In a mix which has been rebonded and reused many times the total combustibles might ultimately rise to 4–10%, from 1.80–1.90% in the original new mix, because of the accumulation of "ineffective" coal in the mix. Such substantial further additions of seacoal to used mixes is of course uneconomical, and leads to a higher ash content in the sand.

We have discovered that the desirable properties and action of seacoal in reused molding sand formulas are substantially enhanced if the seacoal is treated or mixed with a liquid coal tar oil fraction. More specifically, it

has been found that by bringing seacoal into intimate contact with a solubilizing agent containing compounds such as naphthalene and anthracene in which volatiles in the coal are extracted or dissolved out of the coal, there is a substantial reduction in the total quantity of seacoal required in sand mixes utilizing reclaimed or used sand to provide the proper mold atmosphere and to effect proper peel. As a preferred solubilizing agent, we use a so-called neutral oil, which is a liquid coal tar fraction boiling in approximately the 200° C.–400° C. range. Preferably the oil is added to the coal in the amount of about 5% by weight. In some cases, by using coal treated in this manner, the amount of seacoal required to be added can be reduced by as much as 30% or more, depending on foundry conditions. In addition, the finish of the castings is often better, scrap is reduced and economics are improved.

The preferred method of bringing the seacoal (or its equivalent) into intimate contact with the liquid coal tar oil is to treat the coal directly with the oil before the coal-oil mass is added to the foundry sand. However, the coal tar oil can be added directly to foundry sand already containing the coal, or it can be introduced into the foundry sand on a carrier such as a cellulosic material. In each case, the foundry sand mixture will contain the liquid coal tar oil and seacoal and will require smaller amounts of seacoal than would otherwise be required to maintain a controlled reducing atmosphere in the mold.

As examples of commercially available liquid coal tar oils which can be used to reduce the total quantity of seacoal required to be added to the sand mix, the coal tar oils produced commercially designated as K60–1740P, K60–1587P, 1588P, 1589P, 1590P, and 1591P are suitable. These commercially available products contain as major constituents bi- and tri-cyclic aromatics, including the following:

	Boiling point, ° C.
Naphthalene	218
Thionaphthalene	222
2-methylnaphthalene	241.14
1-methylnaphthalene	244.78
Diphenyl	255.2
Acenaphthene	280.7
Diphenylene oxide	287
Fluorene	298
Phenanthrene	340
Anthracene	342.3

A large number of other products are also present in smaller quantities.

Crude coal tar, asphalts, bitumens, and pitches have heretofore been used as additives for sand mixes. However, the materials previously used are extremely viscous solid or semi-solid residues and do not have the same effect as lighter coal tar fractions on the release of volatiles from seacoal in rebonded sand mixes. It should be understood that this invention is not concerned with heavy viscous coal tars as additives for sand mixes, but is concerned only with treating seacoal with much lighter, liquid oil fractions of coal tars, within which the seacoal is partly solubilized.

Most seacoal has a volatile carbon content of 30 to 40% and a fixed (non-volatile) carbon content of 50 to 60%. The volatile carbons are apparently the critical components in respect to controlling the atmospheric conditions within the mold during casting and providing proper peel. We have discovered that it is of the utmost importance that the emission of volatile carbons from the coal begins at relatively low temperatures as the metal enters the mold, and continues for a considerable period if positive control is to be achieved over the mold atmos-

phere. In used sand mixes which have not been rebonded, the low temperature volatiles of the used seacoal, i.e., the volatiles given off in the approximate 200° F.–1200° F. temperature range, have either previously been distilled out and are absent, or are somehow "locked-in" the seacoal so that they are not readily released upon heating at temperatures in that range.

Without intending to limit the invention, it is believed that the reason why smaller amounts of seacoal treated in accordance with this invention are required in rebonding used sand mixes, is that the coal tar liquid, or some of its constituents, "unlock" or solubilize the volatiles in the coal which otherwise would not be released during molding. Apparently new coal contains sufficient "releasable" volatiles to supply the necessary requirements, but in use most of the remaining volatiles apparently become locked in or are rendered less easily releasable, and are thereafter released too slowly for proper effect. This would explain why it has been necessary to use additional seacoal in rebonding. If this theory is correct, the coal tar oil then apparently makes a larger portion of the total volatiles in the coal available, so that less coal is required.

The coke oven tar liquid we prefer to use in treating seacoal actually represents the condensed volatile portion of coking coal which is removed as the coal is being coked. This liquid contains compounds such as naphthalene and anthracene which have the observed solubilizing effect on ground bituminous coal. When the oil is mixed with seacoal, this solubilizing action permits a given percentage of coal to release a greater proportion of the soluble or volatile material than it otherwise would under casting conditions. A smaller percentage of inert carbon is left. By releasing more total volatiles, with a greater proportion coming off in the low temperature range from 200° F. to 1200° F., the finish of the casting is substantially improved and less sand adheres. Because of their solubilizing effect on coal volatiles, tar oils thus substantially reduce the total amount of carbonaceous material required to be added to the reused sand mix.

A typical conventional rebonded used sand mix might comprise:

1600 lbs. reused sand
22–37 lbs. normal seacoal
32 lbs. new clay

In contrast, an example of a rebonded used sand mix utilizing coal treated in accordance with this invention is:

1600 lbs. reused sand
17–22 lbs. treated seacoal
21–24 lbs. new clay

(Both formulations are mixed with sufficient water to plasticize the clays and make a workable molding sand.)

While greater percentages than 5% by weight of liquid coal tar oils could be utilized in the treated seacoal with still further improvements in the amount of low temperature volatiles extracted, these higher percentages do not at present appear to produce commensurately better results, so that 5% represents an economic compromise for obtaining maximum low temperature volatile increase while still maintaining the easy handling properties of the treated seacoal.

An incidental improvement usually resulting from the use of seacoal treated in the manner described above, in addition to the reduction in the amount of seacoal necessary, is a reduction in the amount of new clay necessary to be added to the reclaimed sand. Apparently this reduction in the amount of new clay required in the reclaimed sand mix which includes seacoal treated with liquid coal tars in the manner described above, is derived from a better dispersion of the clay through the sand mix and faster development of the clay properties during mixing utilizing the treated seacoal. This is particularly true when the foundry has adequate sand mixing facilities.

Our invention has been described herein primarily in relation to the treatment of coal additives with liquid coal tar fractions such as neutral oil. It should be understood, however, that other solubilizing agents containing bi- and tri-cyclic aromatics including naphthalene, thionaphthalene, methylnaphthalenes, diphenyl, acenaphthene, diphenylene oxide, fluorene, phenanthrene, and anthracene are also effective for extracting volatiles in coal and are usable herein to reduce the quantity of seacoal necessary in rebonding used sand mixes. Naphthalene and anthracene are especially effective for this purpose, although their cost is high at present. Liquid mixtures containing substantial portions of some or all of the listed compounds, such as are produced in certain petroleum refining processes are contemplated for use herein. Although the listed materials are solids at room temperature in their pure forms, in mixtures such as occur in neutral oil they are liquid, and thus they can more easily be contacted into the coal to extract the volatiles from it.

Having described our invention, what is claimed is:

1. An additive for dispersion in foundry molding sand mix consisting essentially of ground seacoal containing about 5% coal tar neutral oil said coal tar neutral oil boiling in the range of 200° C. to 400° C. and containing as major constituents bicyclic and tricyclic aromatic compounds having boiling points from about 218° C. to about 342° C.

2. An additive adapted to be mixed throughout molding sand, said additive consisting essentially of about 60–99% by weight pulverized coal and 40–1% by weight of an aromatic hydrocarbon oil produced by the distillation of coal tar and boiling in the range of approximately 200° C. to 400° C., said aromatic hydrocarbon oil containing as major constituents bicyclic and tricyclic aromatic compounds having boiling points from about 218° C. to about 342° C.

3. A foundry sand mix comprising 85 to 99% of previously used foundry sand mix, about 5 to ¼% unused clay, and having distributed uniformly therethrough about .25 to 1.0% unused treated coal, said treated coal consisting essentilly of a dispersion of 60 to 99% fine mesh coal and 1 to 40% liquid coal tar neutral oil said coal tar neutral oil boiling at a temperature of 200° C. to 400° C. and containing as major constituents bicyclic and tricyclic aromatic compounds having boiling points from about 218° C. to about 342° C.

4. A foundry molding sand including 85 to 99% reused sand mix, ¼ to 5% new clay and .25 to 10% fine mesh seacoal, said seacoal containing 1–40% coal tar neutral oil said coal tar neutral oil boiling at a temperature of 200° C. to 400° C. and containing as major constituents bicyclic and tricyclic aromatic compounds having boiling points from about 218° C. to about 342° C.

5. A sand in accordance with claim 4 in which said seacoal contains about 5% of said neutral oil.

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