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An Analysis of the Disposition of Used Foundry Sand with Thermal Reclamation

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Abstract

The purpose of this study was to identify the economic and environmental concerns for the disposal, reuse, or reclamation of used foundry sand and show how foundries have developed options to landfills. The sand type and the reclamation processes available are the factors to use in determining whether disposal, reuse, or reclamation is appropriate. The continued use of landfills for disposal of used sand strongly indicates that reclamation and reuse techniques were either not understood or not as economical as disposal. Public concerns and new environmental laws demand that alternate means of disposal for used foundry sand should be developed and used.

Reclaiming used foundry sand appears to be the most likely procedure for used sand management (Good, 1991). This study explains how the reclamation process for used foundry sand operates. A recognition of the generating sources of the used sand was described, as well as the alternatives for reuse, reclamation or disposal as part of the overall used sand management.

Another issue of this study was what to do about fallout from the total used sand reclaimed. Sand reclamation and reuse techniques has allowed foundries to make appropriate decisions related to used foundry sand management (Sand Committee Task Force, 1995).

AN ANALYSIS OF THE DISPOSITION OF USED FOUNDRY SAND WITH THERMAL RECLAMATION

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Chapter 1

Introduction

The foundry industry is old, and its habits are sometimes hard to change. Foundries use large amounts of sand to make castings. One of the old habits is to throw away the sand after the molding process rather than to reuse it which usually means that a reclamation process is necessary.

Foundry sand is either mined or scrapped from river or lake banks. Sand is rather inexpensive to purchase; the primary cost is the freight charges to move sand to individual foundries (Good, 1991). Generally, foundry sand has been disposed of in public landfills at a low cost. However, using public landfills has become an expensive means of disposal as well an embarrassment for any large waste producer. Using landfills for large deposits of waste also implies little concern for the environmental impact of filling up the landfill.

As laws about landfill use are changed as well as public attitudes towards major contributors of waste, the economic decision about landfill use also becomes a perplexing problem because direct comparisons of alternatives to landfill disposal are not well understood (Reier, 1993).

Statement of the Problem

As landfills are being filled up, the need for an alternate use of foundry sand becomes more important. The spiraling cost of landfill usage and the laws that affect landfills also show why alternative systems of disposal are important for the foundry industry. However, the cost of known forms of foundry sand reuse is usually more than the original cost of the sand.

Used foundry sand is generated by a variety of foundry processes. Scrapped cores, excess molding sand, sorted fines, baghouse dust, shakeout sand, and shotblast fines are the primary sources that generate used foundry sand. Many foundries view all types of used sand as one total problem rather than many problems to solve from individual source points. The need to identify and separate the source points that generate the sand, and the need to identify the alternatives available for each of the different generating points are key elements to successful used sand management (Leidel, 1994). These different kinds of used sand require different handling for reclaiming. Therefore, the problem of this study is to describe the source points of used sand and the actual process for each specific source associated with reclaiming and reusing the foundry sand.

Statement of Purpose

The purpose of this study was to identify the economic and environmental concerns for the disposal, reuse, or reclamation of used foundry sand and show how foundries have developed options to landfills. The sand type and the reclamation processes available are the factors to use in determining whether disposal, reuse, or reclamation is appropriate. The continued use of landfills for disposal of used sand strongly indicates that reclamation and reuse techniques were either not understood or not as economical as disposal. Public concerns and new environmental laws demand that alternate means of disposal for used foundry sand should be developed and used.

Reclaiming used foundry sand appears to be the most likely procedure for used sand management (Good, 1991). This study explains how the reclamation process for used foundry sand operates. A recognition of the generating sources of the used sand was described, as well as the alternatives for reuse, reclamation or disposal as part of the overall used sand management.

Another issue of this study was what to do about fallout from the total used sand reclaimed. Sand reclamation and reuse techniques has allowed foundries to make appropriate decisions related to used foundry sand management (Sand Committee Task Force, 1995).

Statement of Need

Most used foundry sand is disposed of in landfills. This practice has filled these limited areas with a tremendous volume. An example is the John Deere Foundry in Waterloo, Iowa. This foundry formerly put all of its used sand in the Blackhawk County landfill which equaled 50% of the total annual volume at this landfill site (G. Wilcox, personal communication, November, 1993).

Both the federal and the state governments have actively pursued regulations regarding restrictions for landfill usage. For example, the state of Iowa has invoked a 50% reduction in the volume that goes to any Iowa landfill by 1996. The five year window for reaching this reduction is still open. The John Deere Foundry has significantly contributed to this reduction by eliminating the used sand it disposes of at the landfill by 90% (R. McDougall, personal communication, January, 1995).

Landfills are filling up and new ones are difficult and expensive to establish. Alternatives to foundry sand disposal are an immediate need for the foundry industry and society. Any large contributor to the landfill volume has a responsibility to its community to eliminate as much of the waste as possible (G. Wilcox, personal communication, November, 1993).

Research Questions

The research questions this study answered were:

1. What are the source points of generating used foundry sand?
2. What types of reclamation are available for used foundry sand?
3. What is the best method of reclaiming used foundry sand?
4. What disposal options are available for sand not fit for foundry use?

Statement of Procedure

This research paper focused on library materials to develop an understanding of the options for used foundry sand reclamation, disposal, and reuse. The sources that generate the used foundry sand were described. Evolution of the reclamation processes was explained and illustrated.

This study also focused on thermal reclamation which allows most of the used foundry sand to be reused in the foundry as new sand. Thermal reclamation was described by illustrating the equipment, reclamation methods, and the sand that is the result of this process.

The dependent variable in this study was which option was the most cost effective: disposal, reclamation, or reuse of the sand the foundry has determined is not reusable for its own purposes. The independent variables are the generating sources, and the methods of reuse, reclamation, or disposal of the used foundry sand.

The sources used in this study are trade journals and American Foundry Society (AFS) studies. These sources identify a foundry's potential for problem areas. Other sources are the journals and registers that describe the changes in the state and federal laws. Altogether, these sources describe the potentials and constraints that exist to make an educated sand management decision.

Definition of Terms

The following terms were defined to clarify their use in the context of this study:

1. Baghouse - Structure used to filter dust and smoke from the air that is cycled through various foundry processes.
2. Core - A sand configuration used in the molding process to create the internal passages in castings.
3. Disposal - To throw away with no future value.

4. Fallout - Sand that is worn down to the point that it can not be reused in the foundry process.

5. Ferrous - Metals that contain iron such as steel or any of the cast irons.

6. Green sand - A mixture of sand, clay, water, and other additives used for molding processes.

7. Non-ferrous - Metals that do not contain iron such as aluminum, copper, or bronze.

8. Reclaim - To treat in some manner so the sand can be reused.

9. Reuse - To use sand more than once in either a foundry or elsewhere.

10. Shakeout - The process in a foundry to remove the casting from the sand mold.

11. Shotblast - The process in a foundry to remove sand from the casting, usually by mechanically throwing steel shot against the casting.

Chapter 2

Review of Related Literature

Sand

Four-fifths of the ferrous and non-ferrous castings in this country are made with a sand-based molding process (Ruzbehi, 1983). This mold sand, along with the cores used to produce the internal passages in the castings, is predominately silica sand (Ziegler, 1994).

Silica sand is inexpensive to purchase because of its wide spread availability. However, transportation costs are driving the total cost higher for new sand and the laws are changing so that cheap disposal is no longer an option (Leidel, 1992).

Silica sand is used to make the molds where molten iron is poured and to make the cores that configure the internal passages of the casting. Control of the sand for both molding and core-make processes is critical to insure that castings are not defective. Control includes testing for moisture level, grain fineness and shape, and cleanliness of the sand grains (Joseph, 1980).

A foundry may have as few as three and as high as six source points that generate used sand. Each of these source points needs to be identified and segregated to appropriately develop the correct option for sand reuse (Lessiter, 1994). Understanding all of the source points is important in determining the potential of the sand for reuse (Carey, 1977).

Scrapped Cores. Scrapped cores are a by-product of the core-make process. These scrapped cores create a large source of used sand (Hayes, 1993). This sand cannot be reused without removing its resin coating. Reusing this coated sand without treatment can lead to unpredictable results such as excess gas in the mold cavity. Gas can cause castings to be scrapped because the gas will cause holes in the casting walls producing an unacceptable product (Heine, 1992).

Sorted Fines. Sand must maintain both size and shape for the foundry processes to maintain continuity (Joseph, 1980). As the sand is used and reused in the molding process, the sand grains eventually break down to a fineness level that is not suitable for continued use in the foundry. Therefore, the sand is screened between each use to insure the correct grain fineness. The broken down sand, or fines, are removed and disposed of (Lumsden, 1993).

Excess Molding Sand. Molding is a foundry process that produces the majority of used sand. Molding sand is made by coating each sand grain with a clay and sea-coal mixture. New sand is evenly added to the molding sand to control the level of fines and allow constant mixing consistency (Reier, 1993).

Molding sand is also generated from the cores put in molds to create castings. Most foundries now create complex castings with a number of internal passages, such as engine heads and blocks. This requires extensive use of sand cores (Peters, 1995). These cores are removed after the casting is poured and cooled down. This process occurs both in the shakeout area and the shotblast area.

Shakeout Sand. Excess mold sand is generated if the core breaks down in the shakeout area. This loose core sand is blended in with the rest of the mold sand, creating an excess of mold sand to contend with. All methods of removing the cores creates used sand that must be managed (Ziegler, 1994).

Shotblast fines. The sand that is shotblasted from the casting has a high level of fines because it was exposed directly to the heat of the molten iron. This intense heat will cause some of the sand grains to fracture. The shotblast itself will damage some of the sand grains. This sand should be tested to insure that reclamation is worthwhile. The fineness level may be elevated so that the reclamation process will not yield a high level of useable sand (Holn, 1994).

Baghouse and Filter Dust. Other source points of sand and silica dust are the baghouses or dust filters placed in strategic areas for foundry processes. This sand consists of small particles too fine to be reused in any foundry process. This means disposal or other reuses outside the foundry are the only alternatives (Hoyt, 1988).

It is not practical to reclaim sources of sand that are too fine to reuse in the foundry process, such as the sand and silica dust that is accumulated by the baghouses and dust collectors. The sand from these sources makes up about 5% of the total excess sand at the John Deere Waterloo Foundry (R. McDougall, personal communication, February, 1995). Beneficial reuse of these sand types is an important consideration in the sand management decision process.

The generating source points of sand described are typical of most foundries (Ziegler, 1994). Managing these individual source points of sand is important to insure that disposal can be kept to a minimum or eliminated.

The remaining 95% of used foundry sand is worthy of further study because of continuing pressures to reduce the volume of used sand deposited in landfills. One of the ways of reusing sand in the foundry is to reclaim it which allows reuse of the sand in the foundry processes as if it were new sand.

Sand, as well as anything foundries use, is a resource that should be valued and reused if possible. Economics, as well as laws and regulations governing the alternatives, will determine which process is chosen. Using the landfill to dispose of used foundry sand has become the normal operation and the cost is accepted rather than questioned. Old management decisions and outdated philosophies of disposal are many times not questioned. The fact that the reclamation process or reuse is different and may cause changes in the disposition of sand is why change occurs slowly (Ziegler, 1994).

Reclamation Methods

The foundry industry has long recognized the need to reuse the sand it consumes rather than throwing it away as is presently the practice. Studies from as early as 1971 recognized the waste of throwing away the volume of used foundry sand (AFS Sand Reclamation Committee, 1984).

To be a responsible citizen, and to contribute to the well-being of the environment, it is necessary to develop means of reuse of any waste material. Foundries are testing both reclamation and reuse technologies. Changes have occurred in waste management, however they are not well understood or accepted by foundry managers (Lessiter, 1994).

Development of reclaiming foundry sand by either mechanical and/or thermal reclamation techniques has been extensive (Reier, 1993; Svododa, 1991; Walker, 1994). On one hand, the cost of a reclamation process is expensive to initiate by existing standards. Yet, the escalating cost of landfilling has made thermal/mechanical reclamation an acceptable alternative in most areas. Increasing pressure from public opinion and new environmental laws is forcing foundries to take another look at this process (Reier, 1993).

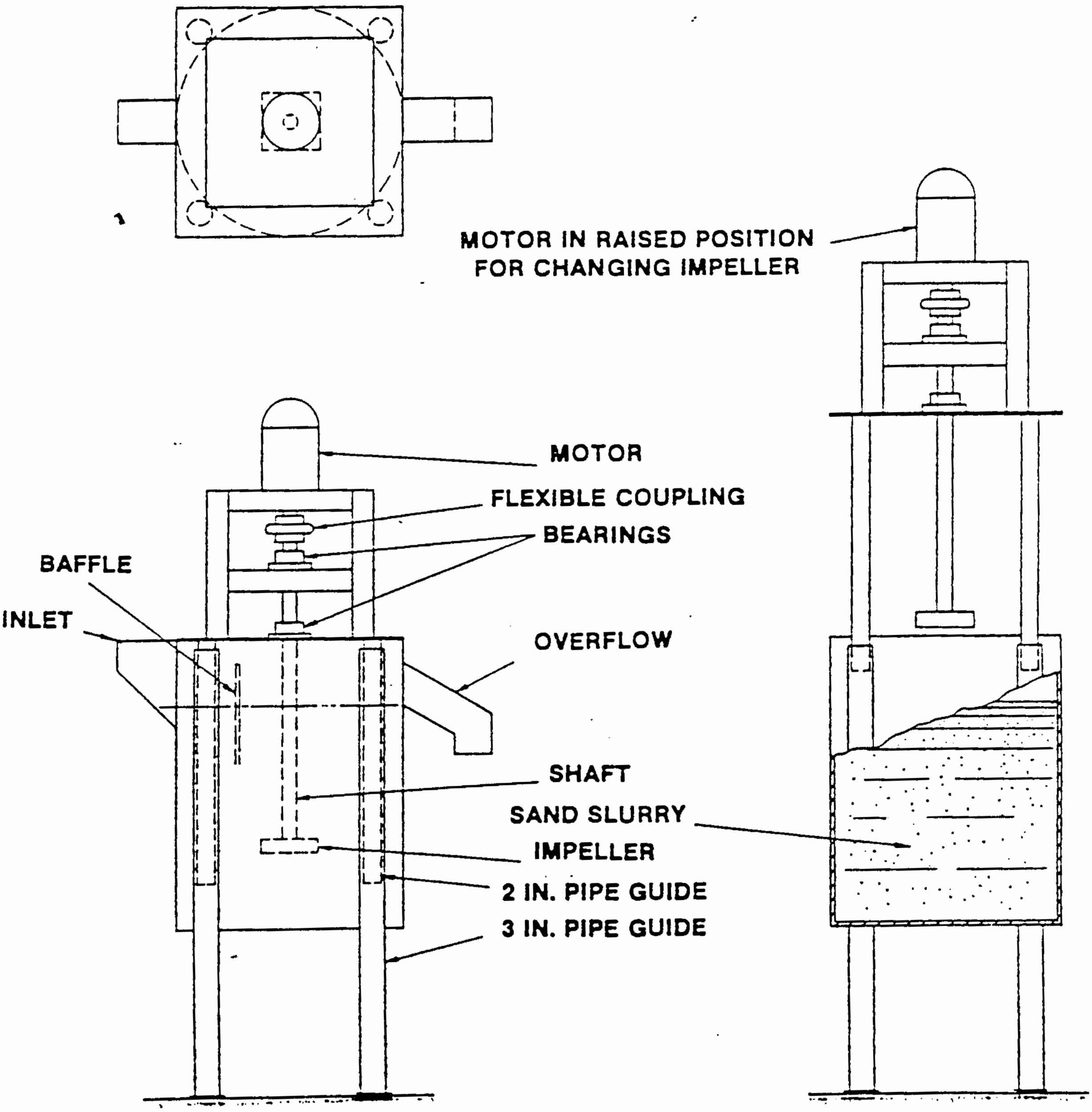
Technology needs to continue to be developed to help the foundry industry decide how to reuse or salvage the sand it uses so freely. The key is to gain acceptance of the developed technology so that it will be supported and practiced (Leidel, 1994).

Wet Reclamation System. Some of the early industrial attempts were to reclaim the scrapped core sand with water and reuse it for core making. This procedure was called a wet scrubbing reclamation method. Figure 1 is an illustration of the wet reclamation method (Good, 1991). This method was somewhat successful, but only a small percent of this reclaimed sand could be used. The reclaimed sand was blended with new sand at relatively low rates (Mason, 1941). Although this procedure reduced the amount of new sand needed, it had a fairly limited affect on reducing the amount of sand thrown away. From this wet scrubber system, the evolution of sand reclamation has progressed to mechanical, pneumatic, thermal and finally the combination of thermal/mechanical processes (Gibbons, 1988).

Mechanical Reclamation System. The mechanical reclamation method was either a vibrating bed of sand or a mixer type barrel that moved the sand so the rubbing action would break and wear off the resin coatings (Hayes, 1993). The resin coating was a result of core processes. This method is illustrated in Figure 2 (Good, 1991). Mechanical reclamation was cheaper

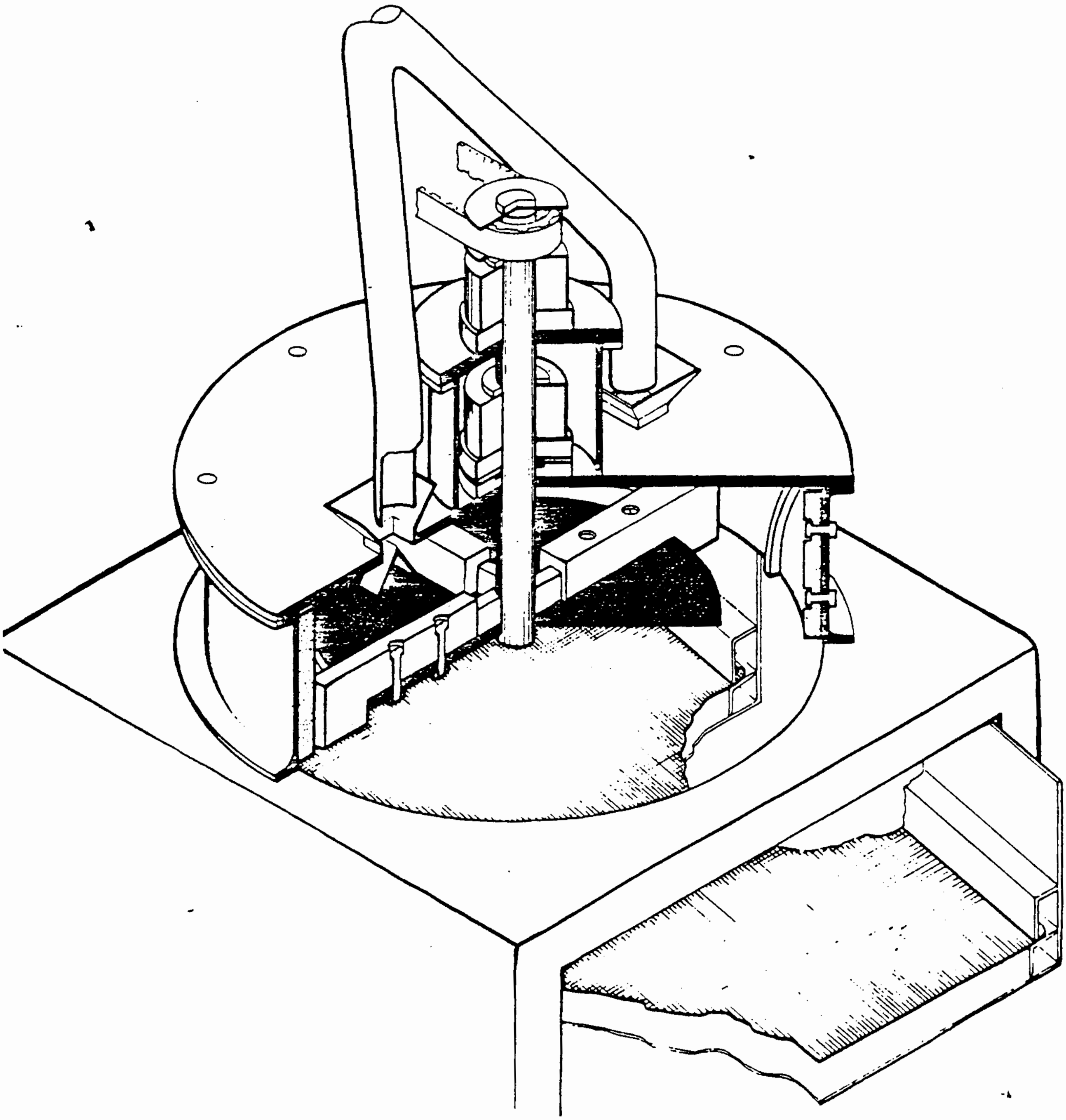
Wet Reclamation System

Figure 1.



Mechanical Reclamation System

Figure 2.



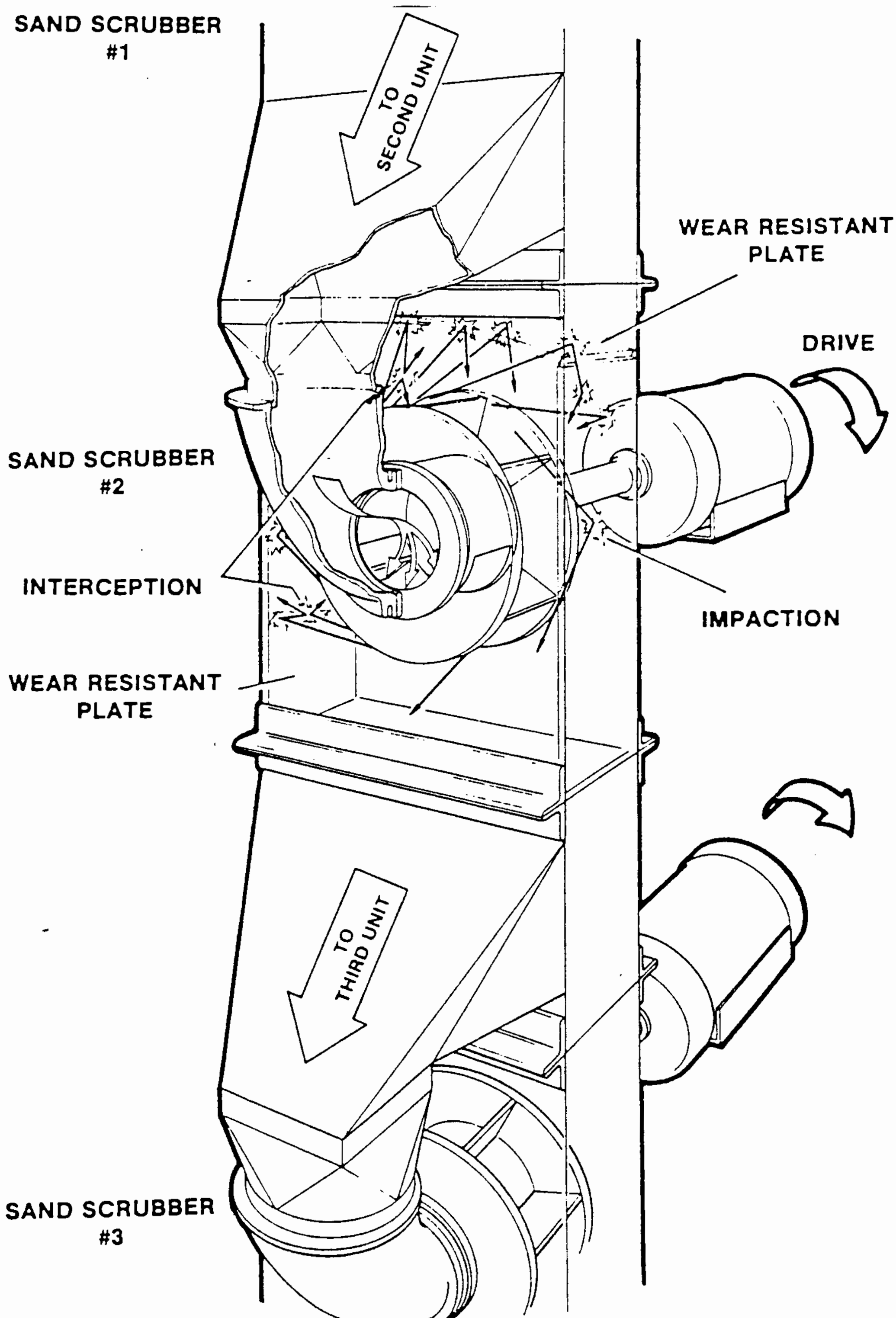
than the wet systems method because the sand did not have to be dried after the reclaiming was finished. Another version of the mechanical method is illustrated in Figure 3 (Good, 1991). This type of mechanical reclaimer threw the sand against a wall or target to break off the resin coating.

Both of these mechanical reclamation processes would remove enough of the resin to allow a portion of the reclaimed sand to be blended with new sand. The drawbacks of these mechanical systems are the same as drawbacks of the wet reclamation systems: only resin coated sand could be reclaimed and only a portion of the reclaimed sand could be blended in with new sand (Hayes, 1993).

Pneumatic Reclamation System. The pneumatic reclamation system in Figure 4 (Good, 1991) had similar results as the mechanical systems. This method used air pressure to blast the sand against a target to remove the resin coating from the sand grains. The same constraint was involved with this process as its predecessor. The sand was still contaminated with residue of resins so that it could only be used if blended in with new sand. The pneumatic reclamation system, as well as its heirs for reclamation, would not completely recondition the resin-coated sand so it could be used as new sand (Hayes, 1993).

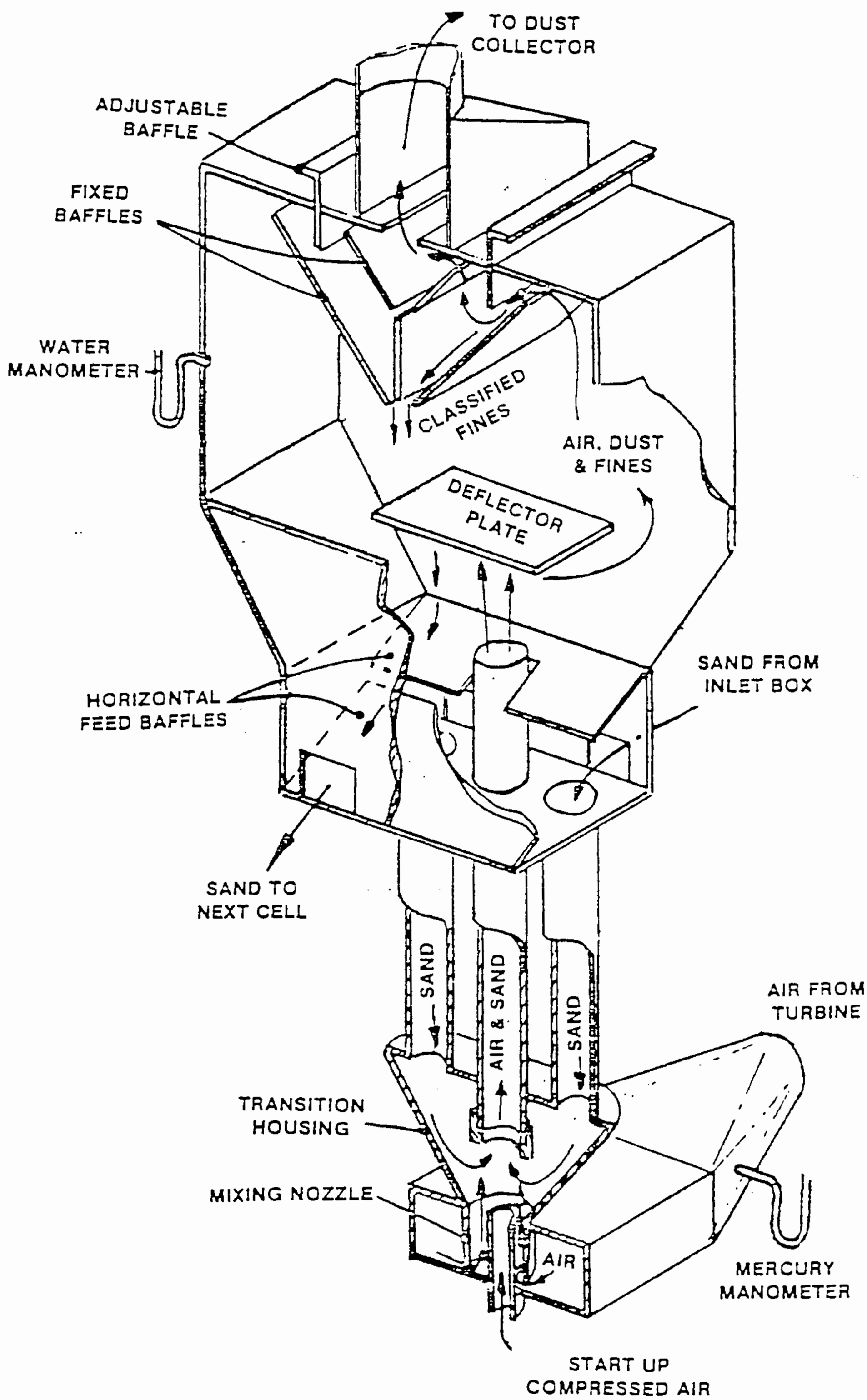
Mechanical Reclamation System

Figure 3.



Pneumatic Reclamation System

Figure 4.



Thermal Reclamation System. Thermal reclamation was next introduced to reclaim resin coated sand. Figure 5 (Good, 1991) illustrates the thermal or calcining process. This process heats the sand to about 1100 degrees Fahrenheit and burns the coating from the sand grains. Although the resin is burned off, an ash covers the sand grain. This ash does not allow the sand grain to be properly covered with resin for reuse as new sand in foundry processes (Bleunstein, 1980).

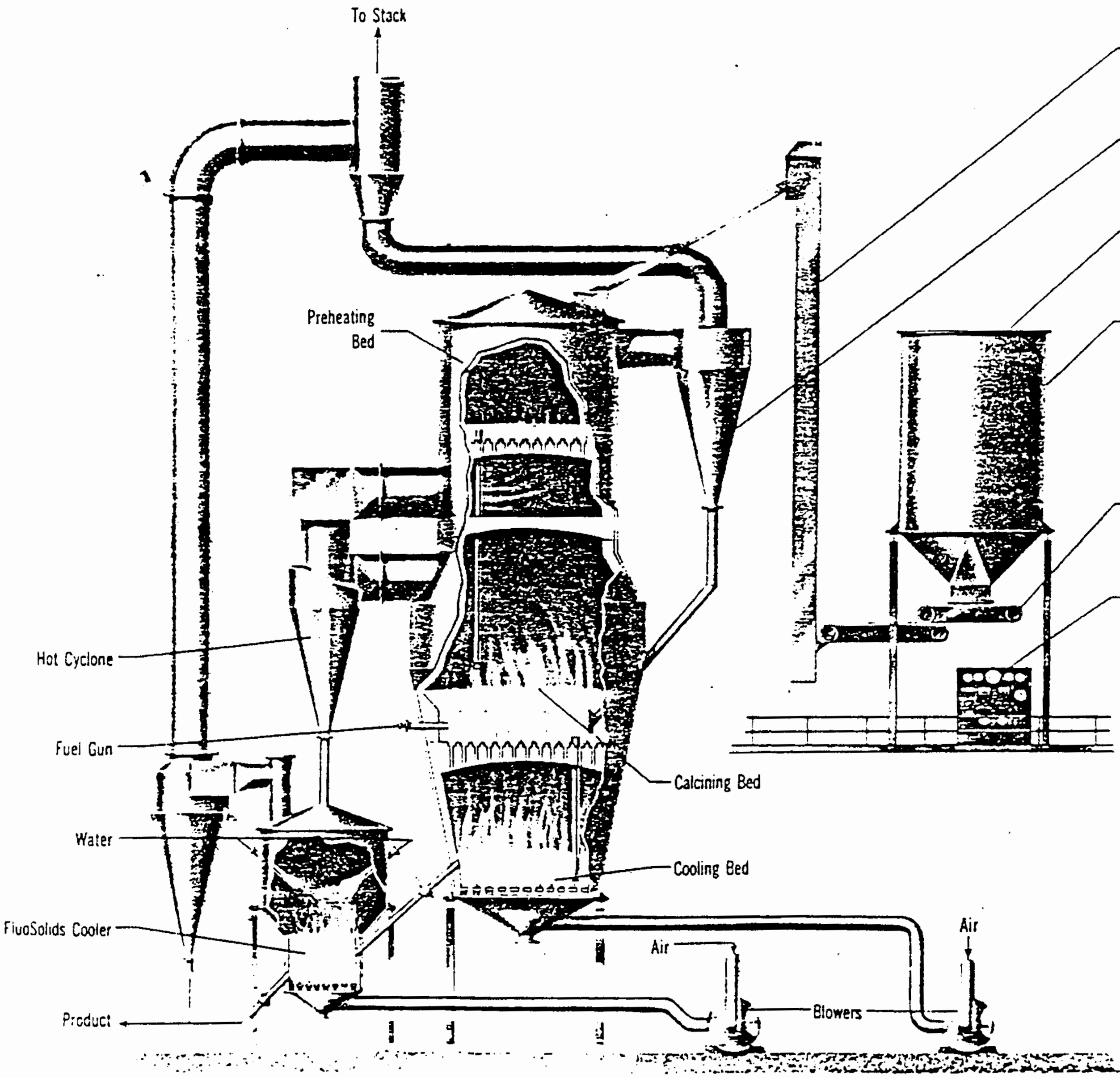
Thermal/Mechanical Reclamation System. The next method in the evolution of used foundry sand reclamation treated the thermally reclaimed sand by a mechanical or pneumatic reclamation process to remove the ash that covers the sand grains. This method allowed the reclaimed sand to be used as new sand, so the reclamation process was complete for resin-coated sand (Good, 1991).

The ultimate goal of sand reclamation is to allow green sand from the mold process to be reclaimed so it can be used as new sand in the core make process (Ruzbehi, 1983). The known practice of thermally treating the green sand and then mechanically scrubbing the sand is the only way that the used mold sand can be reused as if it were new sand (Leidel, 1992).

The thermal/mechanical reclamation method is the latest development in foundry sand management. This process allows both of the primary

Thermal Reclamation System

Figure 5.



sources of used sand to be reused as new sand. The mold and core sand are the primary sources of used foundry sand. These two sources are responsible for 95% of the used sand in typical foundry processes because of the complex castings being made (Reier, 1993).

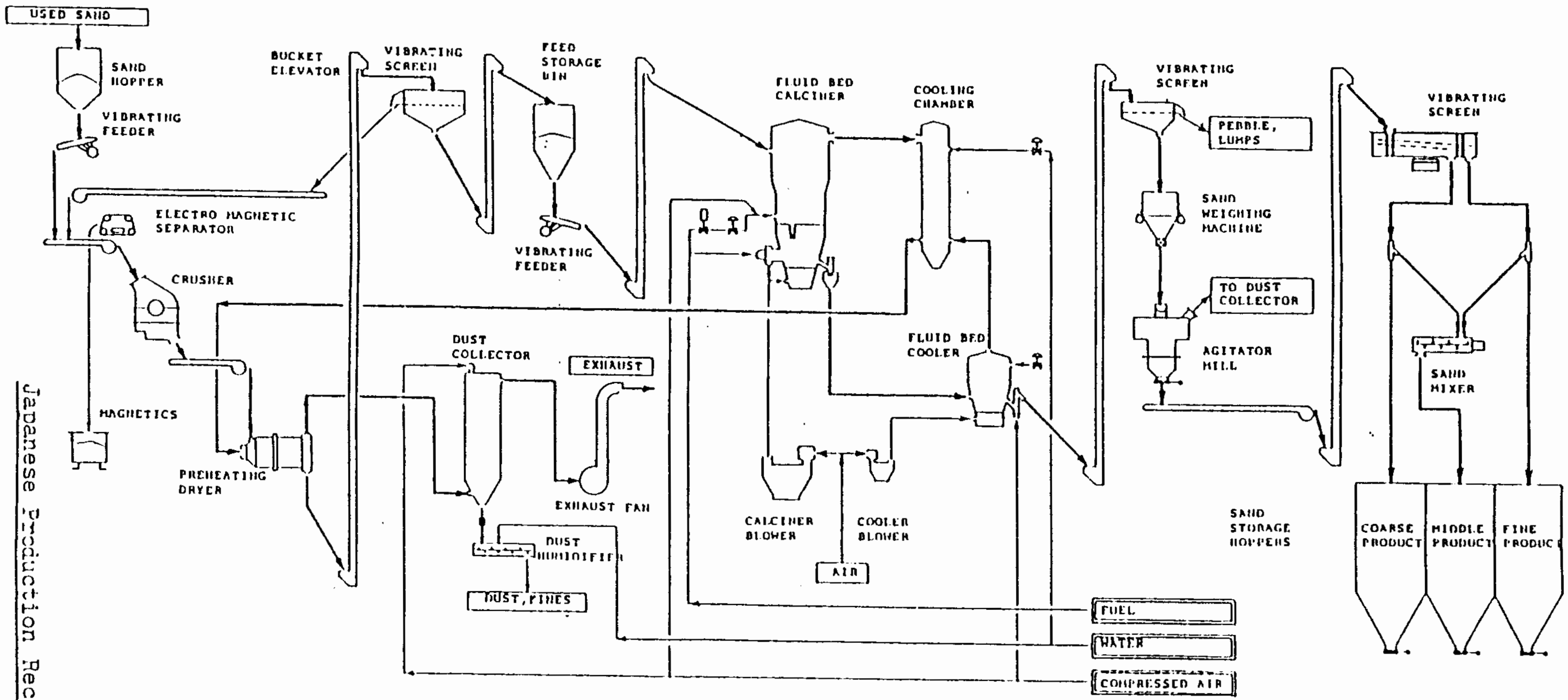
Figure 6 (Good, 1991) illustrates the entire thermal/mechanical reclamation process. Like most reclamation systems, the thermal/mechanical reclamation process starts with a core crusher and/or lump breaker. The crusher and/or lump breaker allows the sand to be treated as individual grains rather than groupings of sand grains held together by resin or pressed together like green sand. Sand must be in an individual form before any reclamation system can be effective (Leidel, 1992).

The sand is moved to a chamber that heats the sand from 1100 to 1400 degrees Fahrenheit to burn off the resin or clay binders. The most popular ways to heat the sand are gas fired, electric coils, or infrared heat treating processes (Lumsden, 1993). Any of these methods are effective. Cost of the equipment and operation will determine which method is used.

The actual thermal reclamation process takes place when the sand is heated in a chamber to burn the clay or resin coating. The heat developed to accomplish this process has to be high enough to burn off the coatings, but too much heat is a waste of money. This process is already costly without

Figure 6.

Reclamation System



Japanese Production Reclamation Plant

adding needless costs. The type of sand coatings to be burned off will determine the amount of heat needed (Lessiter, 1994).

Thermally reclaimed green sand is covered with a calcine layer of clay rather than an ash as experienced when reclaiming resin-bonded sand (Lumsden, 1993). The mechanical reclaiming removes both the ash and the calcine layer to allow the sand to be reused as if it were new sand. This method is the most effective means of reclamation because not only is the resin-coated sand from the scrapped cores reusable as new sand, but green sand from the molding process is also reusable as new sand (Bailey, 1993).

This combined thermal/mechanical reclamation process eliminates the problem of only using a portion of the reclaimed sand as new sand. The final reclaimed sand is as good as new sand as long as the classification process has also been included. Classification is accomplished by using screens or mechanical separators to classify the sand by grain size. Grain sizing is important because grain size distribution is one of the critical elements in making consistent castings (Ziegler, 1994).

The thermal/mechanical combination allows the most output to achieve as close to total reuse as is currently possible. There is approximately a 5% fallout from this process caused by the fracturing of the silica sand. This is a physical outcome of the heat in the casting process and the harsh treatment in the reclamation process that can not be overcome (Dr. F. Vondra, personal communication, September, 1994). Therefore, the unusable portion of the reclaimed sand for foundry processes, must be managed in much the same manner that the non-reclaimable sand must be dealt with.

The cost of the reclamation equipment can be very high for a large used sand producer. The sizing of the reclamation process is critical. The return on investment will have to be studied to insure that the foundry makes a good economic decision (Sand Committee Task Force, 1995). The operating cost is another element that must be studied. In many geographical areas, reclaiming sand has a become a lower cost alternative to new sand (Lessiter, 1994).

Beneficial Reuse

The sand that is either not fit for reclamation or is rejected in the classifying process must also be managed. Several means of reusing this sand are available so it does not add needless volume to a landfill site (Sand Committee Task Force, 1995).

Uses of sorted or used sand include:

- Selling the used sand to a cement company for them to use in their process is a mutually beneficial transaction. The foundry is able to dispose of the excess and/or unusable sand by selling it, and the cement company is able to buy the sand at a fraction of the cost of new sand, a large cost savings for them (Leidel, 1994). Cement companies use a large volume of silica in their formulation to make bagged cement. The most practical way to get silica to make the cement is from silica sand. This is the same sand that the foundry uses, and many times the silica sand comes from the same source (Lessiter, 1993).

- Construction fill as well as roadbed fill is allowed in some states. The volume, in most cases, has to be large for a contractor to be interested enough to use it (Burnley, 1991).
- Fines from foundry processes can be blended in to make both asphalt and concrete for highways (Zirschky, 1988). As much as 15% of the total sand used to make asphalt can be used or rejected foundry sand (Lessiter, 1993).
- Foundries have used excess sand to make bricks and tiles. The components of the molding sand are compatible with the needs of this industry (Sand Committee Task Force, 1995).
- Some states have developed regulations to encourage public landfills to create the layers of waste with used foundry sand. The sand from foundries can be used as a preferred material to perform this function (Sand Committee Task Force, 1995). This practice should not be

interpreted as a useless disposal of this sand, because this will eliminate the use of other materials.

Chapter 3

Findings

Source Points

Most foundries have six generating source points of used sand. Understanding these generating sources is important in determining how to handle the used sand (Lessiter, 1994). The six sources are:

1. Scrapped Cores.
2. Sorted fines.
3. Excess mold sand.
4. Shakeout sand.
5. Shotblast fines.
6. Baghouse and filter dust.

The major sources of used foundry sand are the core and mold processes in a foundry (Hayes, 1993). This is also the best sand for reclamation because the properties of good foundry sand are still intact (Lumsden, 1993).

Reclamation Types

Reclaiming used foundry sand has been a foundry industry goal for a long time. Economics have not been favorable to entice many foundries to change to a reclamation process (Walker, 1994). Increasing costs and controls implemented in local landfills are making a difference in decisions to not use old concepts of disposal of used foundry sand (Ziegler, 1994).

Sand reclaiming has evolved through several different types of processes. Reclamation started with the wet scrubber method, then through the mechanical, pneumatic, and the thermal methods. The latest development is the combination of the thermal with a mechanical process.

Best Method

Thermal reclamation with a mechanical reclamation partner has proven to be the best process because both the green sand and the resin-coated sands can be used as new sand in foundry processes (Ruzbehi, 1983). The thermal process burns off the resin and clay coatings, and the mechanical reclamation process removes the ash and calcine layer that are left on the sand grains. The harsh treatment of the sand requires that a classification process is used to insure that the correct grain sizing is maintained.

Disposal Options

Source points that generate sand too fine for reuse in the foundry should not be reclaimed. These sources are a small portion of the total output of used sand from a foundry (Lumsden, 1993).

Sand that is sorted as too fine either before or after reclamation must also be dealt with. Beneficial reuse is an important option that should be studied and applied when developing a good used sand management program. The number of uses for rejected sand from the foundry have increased. Foundries need to consider the permits that can be granted and the transportation costs to a reuser (Sand Committee Task Force, 1995).

The distance from the foundry to a reuser of sorted sand is important because transportation costs are one of the major expenses for the foundry in the disposal of the sand (Sand Committee Task Force, 1995).

Applications for using this sorted sand include :

1. Raw stock for manufacturing bagged cement (Leidel, 1994).
2. Construction and roadbed fill (Burnley, 1991).
3. Raw stock for asphalt and highway cement (Zirschky, 1988).
4. Raw stock for making bricks and tiles (Sand Committee Task Force, 1995).
5. Cover material for local landfills (Sand committee Task Force, 1995).

The foundry industry must continue to develop uses for its used sand as a resource for another product (Sand Committee Task Force, 1995).

Chapter 4

Conclusion

Environmental regulations, public opinion, and rising landfill costs have insured that landfills are the least practical choice for disposal of used foundry sand (Walker, 1994). Landfills have become a valuable asset for a community and to fill them needlessly is not a responsible act by any business including foundries. This has made it more popular and in most cases more economical to find alternate means of disposing or reusing the used foundry sand

An understanding of how sand is used in a foundry and the generating sources of used sand are the first steps in developing a practical sand management practice (Carey, 1977). The decision on how to treat the used sand must be practical and environmentally acceptable. Reusing the sand in a foundry is the first choice in good sand management practices. To reuse the sand in the foundry will require a reclamation process to make it as clean as new sand.

Reclamation should be the first practice to be studied and used by a foundry that has excess sand. The costs of new sand, including the transportation costs, must be compared with the sand reclamation costs to make a proper decision. In most geographic areas, sand reclamation has a lower overall cost than the purchase of new sand (Lessiter, 1994).

Thermal/mechanical reclamation is the best process to treat the majority of the used foundry sand so it can be reused in the foundry as new sand (Lessiter, 1994). This is the only developed process that will reclaim both resin and clay coated sand to a new condition.

Foundry sand will eventually fracture or wear so that the sand grains are too small to use in the foundry. It is not practical to reclaim sand that is not reusable in the foundry. Even if reclamation is used there will be a fallout of unusable sand that needs to be dealt with.

Beneficial reuses that reduce the volume going to public landfills must be considered for the sand that is no longer fit for foundry processes (Sand Committee Task Force, 1995). There are methods of reusing this sand outside of the foundry environment. Methods of reuse will be different because of the state and local laws in the area that the foundry resides. Transportation costs vary by area so these must be examined to insure the most economical decision is made. The distance to a reuse customer of used foundry sand is a key element in making a proper sand management decision (Leidel, 1994).

A practical sand management decision model will include all known ways of dealing with used foundry sand. Reclamation of used foundry sand is the best means of dealing with this used sand because it can be reintroduced into the foundry processes. The next alternative for used sand that is not reusable in the foundry is to develop a means of beneficially reusing it. The least practical method of dealing with used foundry sand is to dispose of it in a landfill.

Recommendations

Foundries that are still using a landfill to dispose of their used sand will need to understand the options available to them. The laws and regulations that are being imposed must be studied to avoid any monetary fines that will and may be imposed.

Reclamation processes should be studied and tested to insure that it is practical before any investment is made. Some foundries have found it more practical to develop a beneficial reuse for their used sand.

The means of reuse must also be examined to insure that immediate and future liabilities are understood. To reuse the sand outside of the foundry will require a partnership with another company that will require firm understanding of delivery rate and reuse methods.

References

AFS Sand Reclamation Committee (1984, December). Sand Reclamation, Part 1. Modern Casting, 28-30.

Bailey, I. (1993, October). Thermally reclaimed furan-bonded sands. Modern Casting, 36-37.

Bleunstein, J. (1980). Effect of calcining on the ph and adv of foundry sand. AFS Transaction, 167-175.

Burnley, T. (1991, March). Illinois examines the beneficial reuse of spent foundry sand. Modern Casting, 28-29.

Carey, P. (1977, December). Fundamentals of no-bake sand reclamation, Part 1. Modern Casting, 63-65.

Gibbons, C. L. (1988). Evaluation of core sand reclamation processes. AFS Transaction, 77-97.

Good, G. E. (1991). Turning a liability into an asset. AFS Transaction, 58-104.

Hayes, R. A. (1993, May). Reclaiming chemically bonded sands: A technology review. Modern Casting, 37-39.

Heine, H. J. (1992, August). Chemically bonded sand system updated. Foundry Management & Technology, 21-24.

Holn, B. (1994, June). Sand testing--key to quality metalcasting. Foundry Management & Technology, 25-27.

Hoyt, D. F. (1988). A foundryman's perspective on sand reclamation. AFS Transaction, 43-46.

Joseph, R. G. (1980, January). Understanding green sand: A review. Modern Casting, 17-20.

Leidel, D. S. (1992). Toward the closed system by reclaiming green sand. AFS Transaction, 303-312.

Leidel, D. S. (1994, August). Beneficial sand reuse: Making it work. Modern Casting, 28-31.

Lessiter, M. J. (1993, July). Concrete production: An ideal option for foundry sand? Modern Casting, 36-37.

Lessiter, M. J. (1993, November). Constructing new markets for spent foundry sand. Modern Casting, 27-29.

Lessiter, M. J. (1994, August). Putting sand reclamation to the test at General Motors. Modern Casting, 32-34.

Lumsden, B. (1993, May). Research, planning aid selection of sand reclamation system. Modern Casting, 41-43.

Mason, H. (1941). Steel sand prepared by the wet method. AFS Transaction, 1115-1118.

Peters, D. M. (1995, February). Forecasting for castings. Foundry Management & Technology, 24-28.

Reier, G. G. (1993, May). Economics, quality lead move to reclaim clay-bonded sand. Modern Casting, 34-35.

Ruzbehi, M., & Leidel, D. S. (1983, September). Reclaiming clay bonded sand for coreroom use. Modern Casting, 21-24.

Sand Committee Task Force (1995, March). The right thing to do with spent sand. Modern Casting, 27-29.

Svododa, J. M. (1991, May). Evaluating an infrared reclaimer for clay-bonded sands. Modern Casting, 37-39.

Walker, R. N. (1994, March). Foundry reclaims silica electrically. Foundry Management & Technology, 30-32.

Ziegler, M. J. (1994, May). Foundry sand basics. Foundry Management & Technology, 25-29.

Zirschky, J. (1988, June). Cement stabilization of foundry sands. Journal of Environmental Engineering, 114, 715-718.