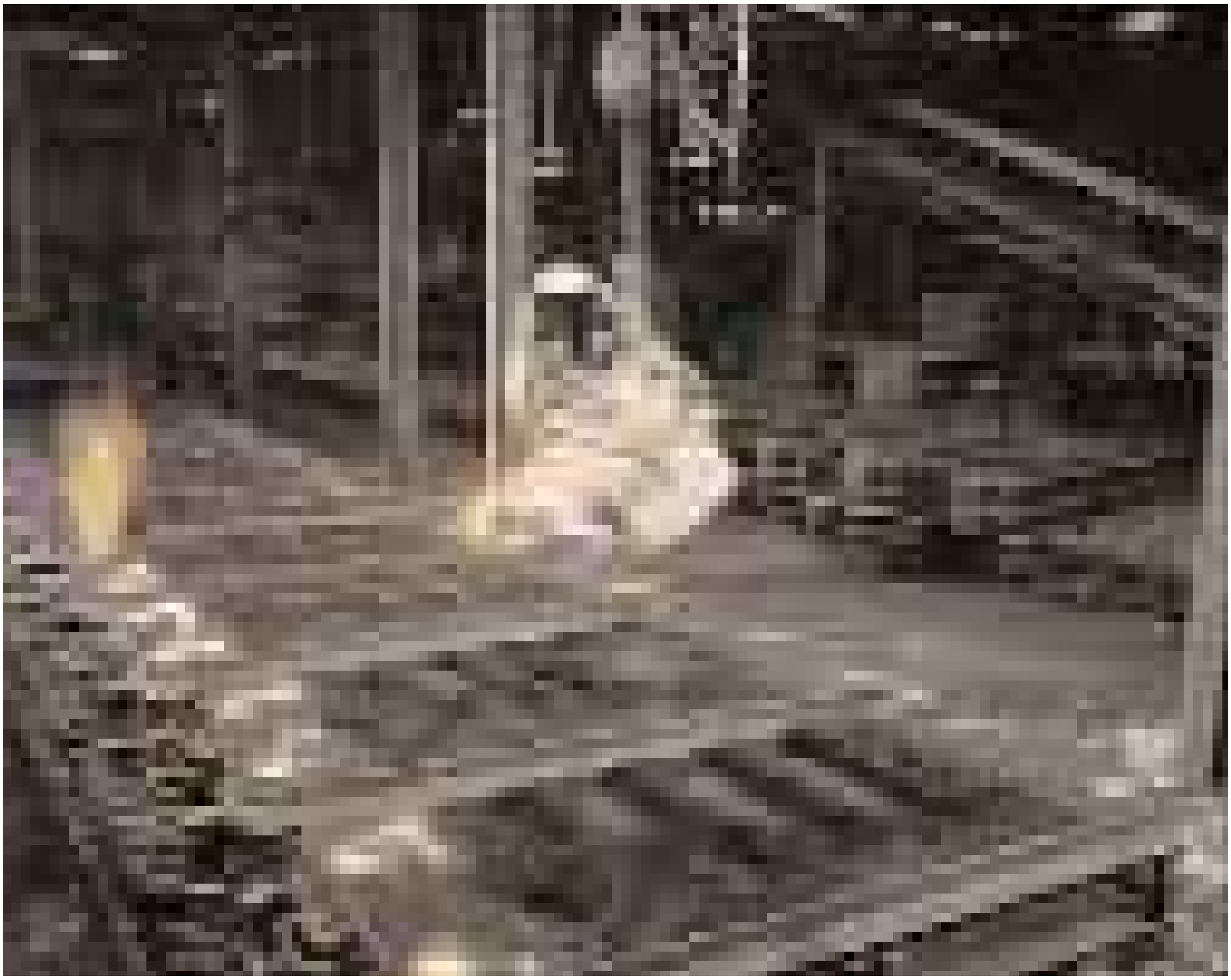
ENVIRONMENTAL
TECHNOLOGY
BEST PRACTICE
PROGRAMME

EG5
GUIDE

# FOUNDRY GREENSAND: USE AND RECLAMATION



**AN ENVIRONMENTAL PERFORMANCE GUIDE:** The benchmark for profitable environmental improvement

# FOUNDRY GREENSAND: USE AND RECLAMATION

This Environmental Performance Guide was prepared for the Environmental Technology Best Practice Programme by Castings Technology International.

ENVIRONMENTAL
TECHNOLOGY
BEST PRACTICE
PROGRAMME

The Environmental Technology Best Practice Programme is a joint Department of Trade and Industry and Department of the Environment initiative managed by AEA Technology through ETSU and the National Environmental Technology Centre.

The Environmental Technology Best Practice Programme promotes the use of better environmental practices that reduce business costs for UK industry and commerce.

The Programme concentrates on two 'permanent themes' to achieve its aims:

**WASTE MINIMISATION**
Management methods for systematically reducing emissions to land, water and air.

**COST-EFFECTIVE CLEANER TECHNOLOGY**
Technological solutions for reducing waste at source.

While these themes are applicable to every industrial sector, the Programme supplements them by focusing on 'areas of special attention' which can either be an industrial sector or a particular pollutant. This Guide was produced specifically for the foundry industry.

The Programme provides all areas of industry and commerce with information and advice on environmental technologies and techniques. This is achieved through the elements described on the opposite page.

*For more information about the Programme please phone the Environmental Helpline on 0800 585794*

## ENVIRONMENTAL HELPLINE 0800 585794
*the gateway to the Environmental Technology Best Practice Programme*

The Programme's Environmental Helpline has access to a wide range of environmental information. It offers free advice to companies on technical matters, environmental legislation, conferences and promotional seminars. For smaller companies, a free counselling visit may be offered at the discretion of the Helpline Manager.

## ENVIRONMENTAL PERFORMANCE GUIDES
*the benchmark for profitable environmental improvement*

Environmental Performance Guides contain data on current environmental performance for a particular industry sector, technology or operation and are compiled on the basis of replies to confidential questionnaires. The Guides enable individual companies to compare their performance with that of others undertaking similar operations and to identify potential areas for improvement.

## BEST PRACTICE IN ACTION
*environmental improvements that save money*

### GOOD PRACTICE

*Proven technology and techniques for profitable environmental improvement.*

Good Practice Guides are handbooks that provide detailed guidance on proven technologies and techniques that save money and reduce waste and pollution.

Good Practice Case Studies are prime examples of proven, cost-effective technologies and techniques that have already improved environmental performance. Independent experts evaluate projects that have been implemented in industrial companies, and the details are published in Programme literature. In return for co-operating with this process, host companies are eligible for access payments of up to £10 000.

### NEW PRACTICE

*New technology and techniques for profitable environmental improvement.*

The aim of New Practice is to help UK industry and commerce to adopt new technologies and techniques that save money and reduce waste and pollution.

New Practice Case Studies are the first commercial applications of innovative measures that improve environmental performance. As with Good Practice, independent experts evaluate the projects and the details are published in Programme literature. In return for co-operating with this process, host companies are eligible for access payments of up to £50 000.

### FUTURE PRACTICE

*Tomorrow's technology and techniques for profitable environmental improvement.*

This is the Programme's Research and Development element. It supports work progressing novel environmental technologies and techniques. The results of Future Practice projects are published to encourage companies to take up successful developments.

# SUMMARY


This Environmental Performance Guide presents data on efficiencies of greensand use and reclamation in UK foundries. Information was gathered from a representative sample of companies on an unattributable basis using a confidential questionnaire.

The aim of this Guide is to make foundrymen aware of:

- the current amount of sand used as a raw material in UK foundries;
- the associated purchase and disposal costs;
- the current amounts of sand being reclaimed;
- the quantities of sand going for disposal;
- their competitors' performance;
- the potential for cost savings through more effective and efficient sand management.

The Guide enables an individual foundry to compare its performance with that of others in the same sector. Overview histograms showing sand use per tonne of finished casting and equivalent sand purchase costs demonstrate the considerable scope for improvement that exists within the UK foundry industry.

The Guide outlines the current issues facing the UK foundry industry and discusses greensand components and costs, sand reclamation and waste sand disposal in the main alloy sectors.

Nearly all greensand foundries in the UK use primary reclamation. The survey revealed that over 25% of foundries currently achieve a 'best practice' addition rate of less than 2% new sand in the total sand mix. Most of these foundries are using the unit sand system, whereas those foundries reporting higher rates of new sand addition are mainly using a facing sand/backing sand approach. The average addition rate for all greensand foundries is 3.5%. If foundries reduced the addition rate to less than 2%, annual sand consumption could be reduced by 210 000 tonnes.

A foundry operating at comparatively high sand-to-liquid metal ratios could reap benefits in reviewing its moulding process with a view to reducing sand consumption. Re-appraisal of the need for multiple binder systems for coremaking is also recommended.

Minimising the amount of sand used reduces the amount of new sand consumed by the foundry and thereby reduces production costs. Sand use can be reduced by:

- minimising new sand addition rates;
- using lower sand-to-liquid metal ratios;
- improved sand and process management.

A sand action plan that focuses on measures to reduce sand costs, reduce sand use and optimise waste sand disposal/reclamation is presented.

This Guide discusses the results of a survey of foundries that use greensand. The use of chemically bonded sand in UK foundries is examined in a complementary Environmental Performance Guide available on request through the Environmental Helpline 0800 585794.

# CONTENTS

# 1 CURRENT ISSUES FACING THE UK FOUNDRY INDUSTRY



This Environmental Performance Guide discusses the use and reclamation of greensand within the UK foundry industry. It examines in detail the cost of sand use, reclamation and disposal across the three largest alloy sectors where greensand is used for moulding ie:

- iron;
- aluminium;
- copper.

There are very few steel foundries using greensand for moulding. However, some survey data were obtained from the steel sector and these are discussed where appropriate.

Until recently, UK foundries did not consider waste sand disposal to be a major problem; the sand was either disposed of on-site or to local landfill sites. To give some idea of the scale of the problem, the current cost to the UK foundry industry for over one million tonnes (t) of new sand used every year, and its subsequent disposal, is about £32 million.

The amount of sand purchased per tonne of casting produced in the three largest alloy sectors of the foundry industry is shown in Fig 1. Fig 2 shows sand purchase costs. The sectors, and individual foundries within each sector, have different production requirements. These production requirements mean that some foundries will need to use more sand than others. However, despite these factors, the figures overleaf show that there is scope for overall improvement in sand use within all alloy sectors.

Sand for foundry use is a finite resource that must possess certain chemical and physical characteristics. As stocks deplete, sand will become more difficult to obtain and therefore more costly to buy. Already, the post-quarrying costs of improving the mineral to meet the acceptance criterion of foundries has meant that raw material costs have risen. The high investment costs required to extract the sand has also led to some quarries being closed without all of the raw material being extracted. Sand is now often transported from further afield, which increases delivery costs. The constraints being placed on sand excavation operations - eg post-closure landscaping requirements - have also added to the problem of increasing costs for quarry operators.

Similar factors affect disposal costs. There are now fewer licensed landfill sites available for the disposal of controlled wastes. Therefore, waste sand has to be carried greater distances for disposal, resulting in increased transportation costs. Moreover, tighter legislative control of wastes and waste disposal sites has led to a rapid escalation in disposal costs. The landfill tax will also increase the cost of waste disposal to landfill.

Foundries now appreciate that these cost trends are irreversible. Better sand management techniques need to be developed and implemented if foundries are to remain competitive.

The foundry industry produces a wide range of castings using many different processes. This diversity, coupled with the variation in size and number of castings produced by foundries, has hitherto made it difficult for an individual foundry to establish its performance relative to other foundries in its particular sector.

Nevertheless, by using Figs 1 and 2, the information given in this Guide and the sand action plan in Section 9, foundries can now improve an important aspect their environmental performance and obtain cost benefits by implementing better management of sand and other raw materials.

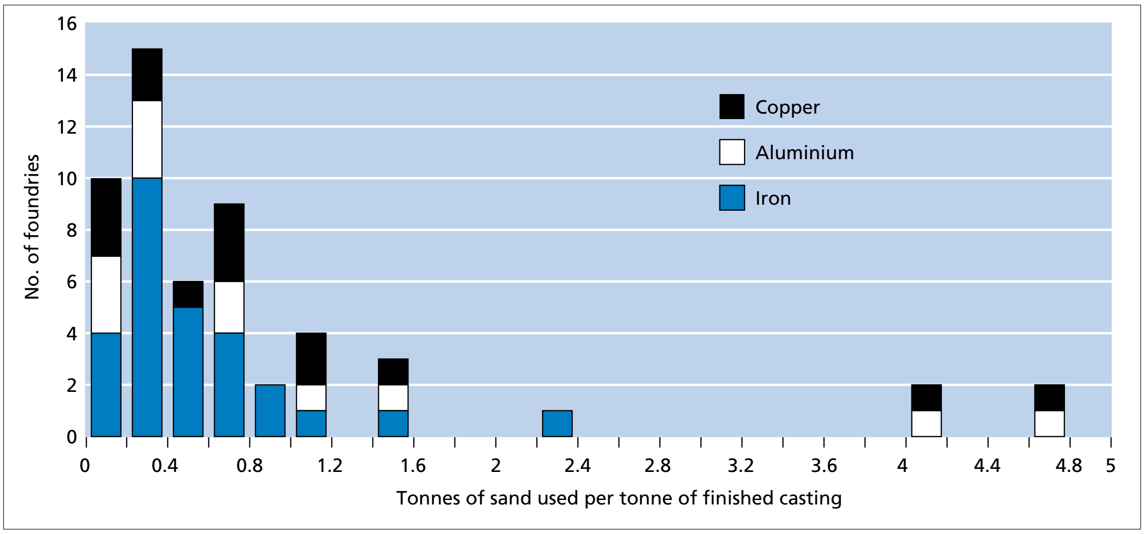



*Fig 1  Amount of sand purchased per tonne of casting produced*

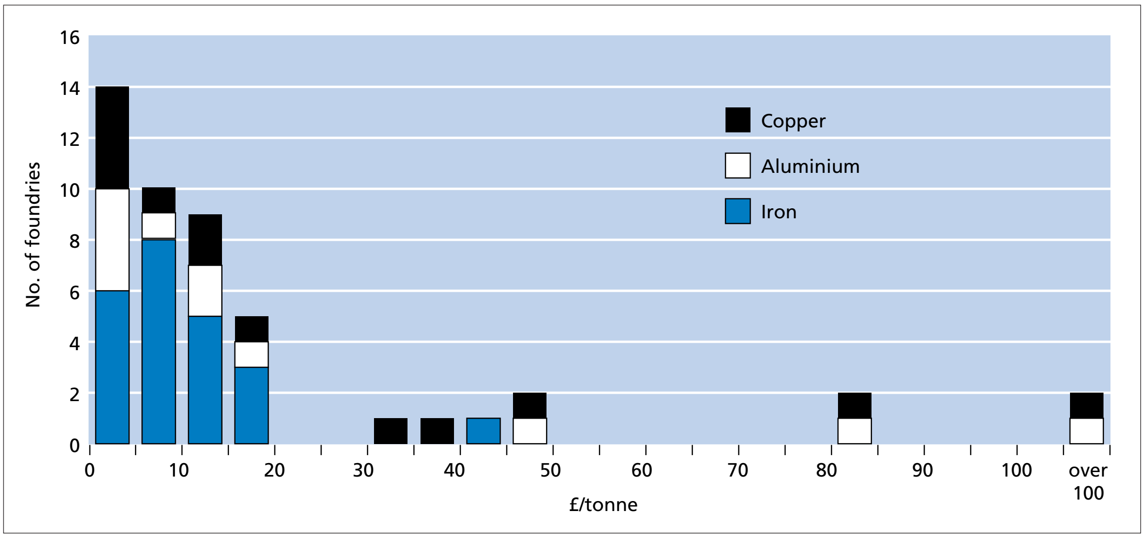



*Fig 2  Purchase cost of sand per tonne of casting produced*

# 2 SURVEY METHODOLOGY AND RESPONSE PROFILE



## 2.1 SURVEY METHODOLOGY

The foundry industry information presented in this Guide was collected by means of a confidential postal survey conducted by Castings Technology International (Cti) on behalf of the Environmental Technology Best Practice Programme (ETBPP). A mailing list of 450 foundries that perform sand casting was constructed from lists of companies held by the ETBPP and Cti, and from the 1994 Foundry Yearbook. Each foundry on the list was contacted by telephone to establish if it used chemically bonded sand or greensand for moulding. Of the foundries using greensand, 73% also used chemically bonded sand. These foundries were also included in a separate survey of foundries using chemically bonded sand. The use and reclamation of chemically bonded sand in UK foundries is discussed in a separate Environmental Performance Guide.

Questionnaires were then sent to a final list of 299 representative foundries that use greensand. These foundries were classified according to the main alloy type produced. Owing to the relatively small number of foundries producing specialist alloys, data pertaining to the production of nickel alloys were combined with that for steel and are discussed where appropriate. Production of lead and zinc alloys was combined with that for aluminium, and other non-ferrous alloys were combined with copper. This classification was also used for the data analysis.

The distribution of the 299 foundries between the four alloy sectors is shown in Fig 3.

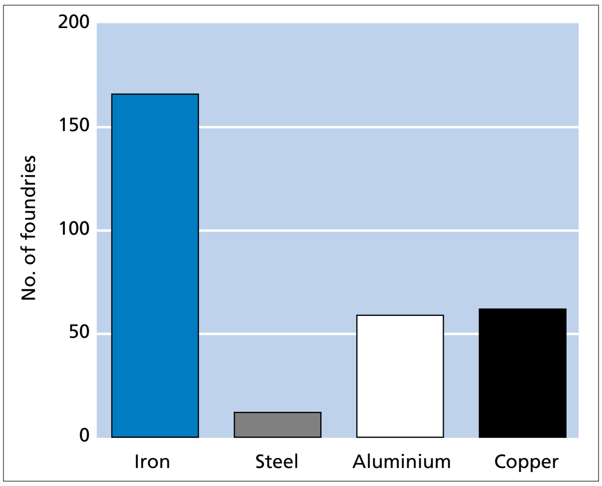



***Fig 3 UK foundries using greensand moulding systems***

## 2.2 RESPONSE PROFILE

Table 1 shows the number of foundries using greensand in each alloy sector and the response rate from each sector.

| Foundry type | Number of foundries | Number of respondents | Percentage respondents |
|---|---|---|---|
| Iron | 166 | 32 | 19% |
| Steel | 12 | 2 | 17% |
| Aluminium | 59 | 10 | 17% |
| Copper | 62 | 14 | 19% |
| TOTAL | 299 | 58 | 19% |

***Table 1 Survey response by foundry type***

Although the percentage response rate was similar for all four alloy sectors, the much larger size of the iron sector means that it was responsible for over half the returned questionnaires. As a result, most of the discussion of environmental performance in this Guide is based on data received from the iron sector. The conclusions drawn from these data are, however, generally applicable to the other alloy sectors.

The returned questionnaires also reflected the size distribution of the UK foundry industry, with its high proportion of small and medium-sized businesses (see Table 2).



| No of employees | No of respondents |
|---|---|
| 1 - 9 | 13 |
| 10 - 19 | 11 |
| 20 - 49 | 17 |
| 50 - 99 | 8 |
| 100 - 199 | 6 |
| >199 | 3 |

***Table 2 Size of survey respondents***

The response profile can be examined further by comparing the average quantity of sand purchased annually with an estimate of the industry average. The amount of silica sand consumed annually by the foundry industry is estimated to be about 1.1 million tonnes (t). The total number of sand moulding foundries in the UK is estimated to be about 450. Allowing for about 34 000 t of sand used by the gravity die-casting sector (excluded from this survey), the average annual amount purchased by a sand moulding foundry is estimated to be 2 400 t. In comparison, the average quantity of sand purchased annually by the foundries that replied to the survey is 2 000 t. This implies that there were more replies from small foundries than from large ones.

Survey data were obtained from 19% of the foundries approached. The response profile also appears to be a fairly good reflection of the industry. It is therefore considered reasonable to extrapolate the results from the survey to the UK foundry industry as a whole.

# 3 INTRODUCTION TO GREENSAND COMPONENTS AND COSTS

The first action in reviewing any manufacturing process is to quantify the consumption and costs of raw materials and resources. Once a foundry has optimised its purchasing policy, it is then in a position to evaluate the cost benefits of improving materials use. This section discusses the key components to be considered.

Greensand consists of silica sand and clay to which, in some cases, coal-dust, coal-dust substitutes or cereal binders are added. The clay acts as the bonding agent during moulding.

Some foundries use 'naturally bonded' greensand where the clay is already present in the purchased silica sand. The majority of foundries, however, prefer to add a proportion of clay to clean silica sand to obtain the desired mixed sand properties. This is known as a 'synthetic sand' system. Within the mixing process it is important to manage the consumption of all components to minimise costs and the effects on the environment.



## 3.1 CLAY AND OTHER ADDITIVES

A variety of proprietary clays are currently available, the two main groups being based on sodium bentonite and calcium bentonite.

Coal-dust or coal-dust substitutes are used in iron foundries to generate both a reducing atmosphere and lustrous carbon in the mould cavity. These attributes are beneficial in improving surface finish and reducing the incidence of defects such as scabbing.

Some foundries add cereal binders to greensand to improve its properties. The two main types of cereal binders are starch and dextrin. Starch improves the flexibility of the greensand, facilitating pattern stripping with difficult castings and reducing the risk of expansion defects. Dextrin is used with high-pressure moulding systems to reduce friability and increase flowability and stripping properties. Use of excessive amounts of cereal binders may lead to problems during the moulding operation and with sand hoppers. Cereal binders should, therefore, only be used where absolutely necessary. Additions should be rigorously controlled because levels are difficult to monitor.

### 3.1.1 Use of different materials

The use of clays and additives in the various alloy sectors is shown in Fig 4.

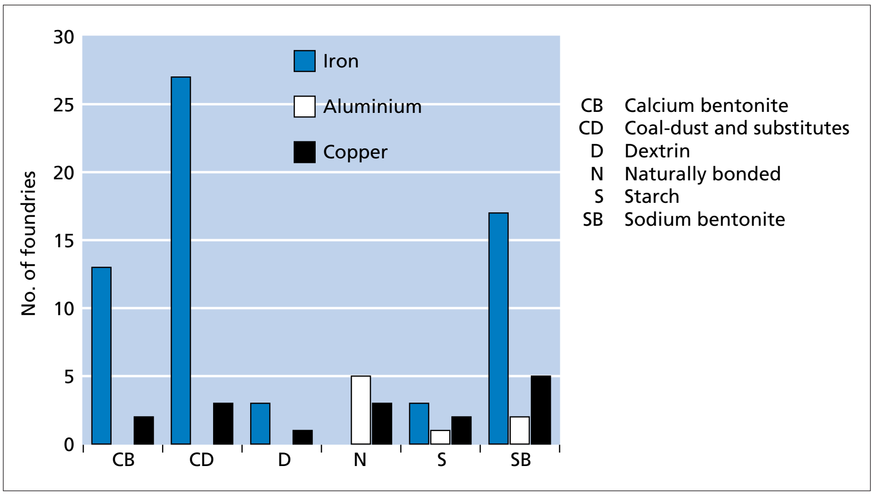



*Fig 4 Use of clays and other additives in foundries*

# 3.2 COST OF GREENSAND COMPONENTS

Purchase costs contribute to the overall cost of the greensand system. The range of costs for greensand components revealed by the survey (see Figs 5 - 8) suggests that those foundries paying the higher prices may benefit from a review of purchasing policy. The costs of the various components are discussed below.

## 3.2.1 Silica sand

Fig 5, which includes information from the chemically bonded survey, shows the range of prices paid by UK foundries for silica sand - the basic raw material for greensand systems. The average price paid for silica sand is currently £20.40/t.

The purchase price of sand has four components - extraction, preparation, packaging, and transport. The inset data in Fig 5 show a considerable spread in the price per tonne for different amounts purchased annually. This is probably due to transport costs.

## 3.2.2 Clay

The prices paid by UK foundries for sodium bentonite and calcium bentonite are shown in Figs 6 and 7 respectively. The average price paid is £128/t for sodium bentonite and £122/t for calcium bentonite.

## 3.2.3 Coal-dust/coal-dust substitutes

The range of prices paid for coal-dust and coal-dust substitutes by UK foundries is shown in Fig 8. The average price is £140/t.

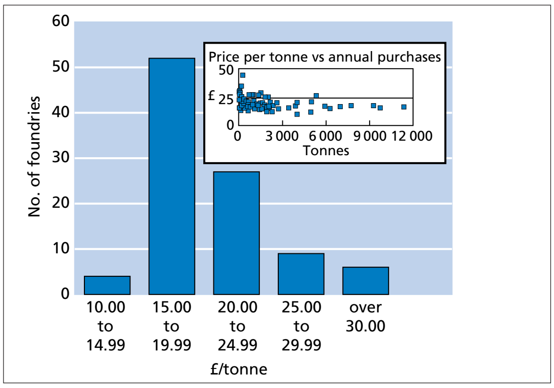



*Fig 5 Purchase price of silica sand*

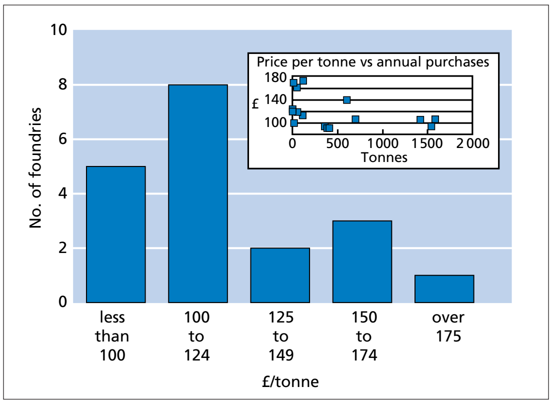



*Fig 6 Purchase price of sodium bentonite*

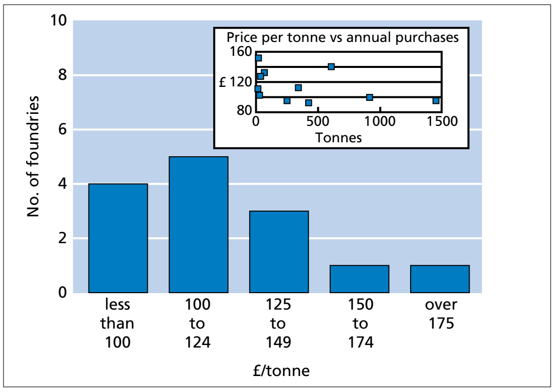



*Fig 7 Purchase price of calcium bentonite*

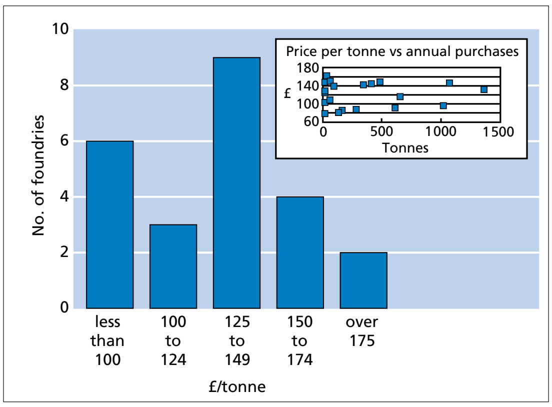



*Fig 8 Purchase price of coal-dust and substitutes*

# 4 SAND RECLAMATION

The degree to which sand reclamation is used within a foundry is another factor that influences operating costs. Maximising the amount of reclaimed sand will reduce purchase costs for new sand and disposal costs for waste sand.

When considering greensand reclamation, a distinction is drawn between primary and secondary reclamation. Primary reclamation is where the sand from moulds or cores is broken down to its original grain size, or small particles, and detrimental fines and clays are removed. Secondary reclamation involves further processing of the sand to remove residual additives and contaminants and return the sand to a quality similar to that of new sand.

## 4.1 PRIMARY RECLAMATION OF SAND IN UK FOUNDRIES



Primary reclamation is used by virtually all UK greensand foundries, though the degree of sophistication of the reclamation plant varies widely from a simple manual operation to fully automatic computer-controlled equipment.

A proportion of sand is discarded from the system on each cycle to allow for the addition of new sand, replacement clay and other materials.

## 4.2 ADDITION OF NEW SAND TO THE SAND MIX

Pouring molten metal into a greensand mould subjects the moulding sand to considerable heat. This heat removes moisture from the sand and destroys both clay and additives, particularly in the vicinity of the mould face.

The amount of sand affected by the heat from the molten metal depends on the:

- pouring temperature;
- casting section thickness.

Higher pouring temperatures and heavy metal sections produce more heat degradation.

The residues left by the thermal decomposition of clays and additives can have an adverse affect on greensand properties. New sand is usually introduced into the sand system to dilute these residues. The addition of new sand is accompanied by appropriate amounts of clay, coal-dust, moisture and other additives. This approach is frequently referred to as a unit sand approach.

Another approach, which is particularly favoured by smaller foundries and by those using natural sand systems, is the facing sand/backing sand technique. The facing sand, which is either natural sand or synthetic sand, is applied to the pattern face as a relatively thin layer. The backing sand, which is collected from the knock-out station, is used to complete the filling of the moulding box. The properties of the backing sand are not as critical - their main requirement is to provide sufficient strength to keep the sand compact in the box. This approach does, however, use more new sand than a unit sand approach.

Foundries using the facing sand/backing sand technique, should consider using the unit sand approach. However, steel foundries considering using a unit sand system should review casting quality as well as mixed sand properties and the overall economics of the change. In particular:

- unit sands lose some refractory properties due to a lower percentage of new silica sand;
- extraneous materials such as refractory holloware, metallic particles, feeding sands, etc, can cause surface imperfections on the casting;
- the presence of 'dead' clay and variable sand temperatures make water additions to achieve the optimum sand properties extremely difficult to manage and require constant monitoring.

### 4.2.1 New sand addition rates

While the level of new sand addition is governed by a number of factors, the usual range is 10 - 20% of the poured metal weight. However, it is more convenient to consider new sand additions as a percentage of the sand throughput. For most foundry processes, a 5% addition of new sand is considered sufficient. The sand from the breakdown of cores (where these are used) is often classed as part of, or even the complete requirement for dilution sand as an alternative to adding new sand.



Fig 9 shows the percentage of new sand used in UK greensand foundries in relation to the total mixed sand. While the average new sand addition rate of 3.5% is close to that considered sufficient, a significant number of foundries were above this value. Any foundry with higher-than-average new sand addition rates should review its sand use practices. In addition, Fig 9 shows that many foundries operate successfully with lower new sand addition rates.

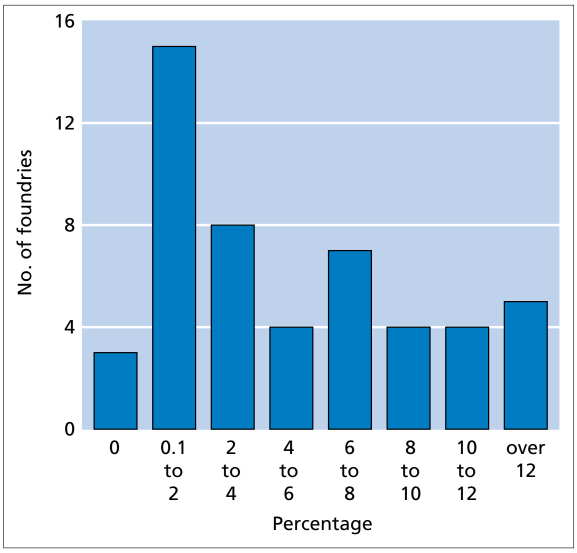



*Fig 9 Percentage new sand in total sand mix*

New sand addition rates in the iron and copper sectors are shown in Figs 10 and 11 respectively. Fig 10 shows that over 35% of iron foundries use less than 2% new sand. This current 'best practice' addition rate is not achieved by all, however, and there is considerable scope for some foundries to further reduce their new sand use. Copper foundries are also operating with varying new sand addition rates (see Fig 11).

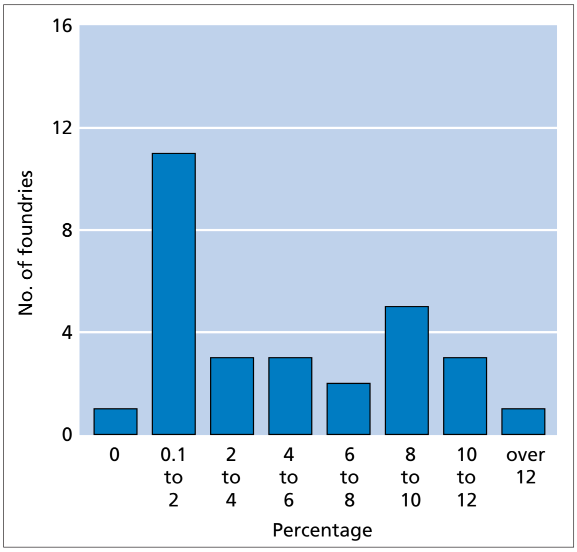



*Fig 10 Percentage new sand in total sand mix in iron foundries*

Most of the foundries operating at less than 2% new sand addition are using the unit sand system, whereas foundries using more than 6% new sand are mostly using a facing sand/backing sand technique.

The foundries that responded to the survey purchase over 100 000 t of new sand annually. Assuming that these foundries are representative of the industry as a whole, the amount of new silica sand purchased annually by the industry is about 500 000 t. Assuming an average new sand addition rate of 3.5%, then nearly 14 million tonnes of mixed greensand is produced each year. If foundries reduced the addition rate to less than 2%, then annual sand consumption could be reduced by 210 000 t.

## 4.3 SECONDARY RECLAMATION

All UK greensand foundries currently treat the discarded sand proportion as a waste material for disposal. This sand could, however, be treated by secondary reclamation techniques to render it fit for use in place of new sand. This would reduce sand purchase and disposal costs, and lead to a reduction in waste to landfill.

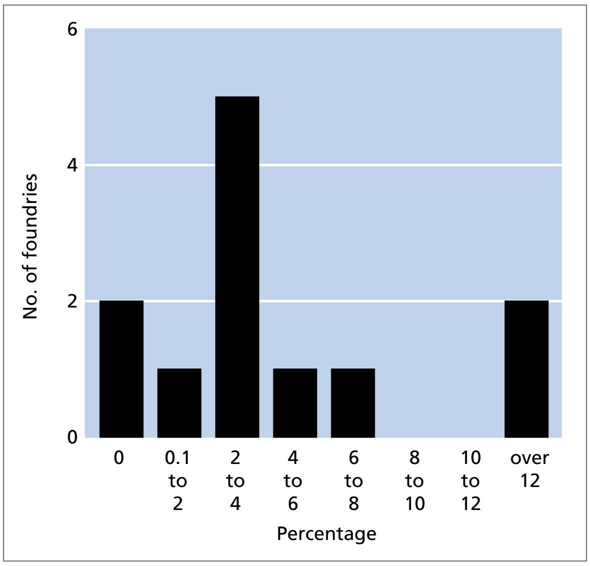



***Fig 11  Percentage new sand in total sand mix in copper foundries***

Technologies for secondary reclamation of greensand have been used in several countries, notably the USA, for a number of years. Large foundries in the USA that use secondary reclamation commonly use a combination of mechanical attrition, wet scrubbing and thermal treatment.

Economic and environmental considerations are expected to result in increased pressure on greensand foundry operators in the UK to adopt secondary reclamation techniques. Many UK foundries using large volumes of sand have already started to evaluate secondary reclamation technologies.

# 5 SAND-TO-LIQUID METAL RATIOS

Sand-to-liquid metal ratio - ie the amount of sand mixed per tonne of metal poured - is a further parameter that can be controlled to optimise sand use and reduce operating costs.

Most greensand foundries primary reclaim, and then re-use, over 90% of the mixed sand. The sand-to-liquid metal ratio is therefore less critical to sand use in a greensand foundry compared with a chemically bonded sand foundry, where a much larger proportion of the mixed sand is discarded.

Most greensand foundry operators use a limited number of moulding box sizes - in many cases it is a single unit. The castings are therefore arranged in those combinations best suited to the available box space. These arrangements, however, may not always result in optimum box utilisation and may encourage high sand-to-liquid metal ratios.

The lower strength characteristics of greensand compared with chemically bonded sand may also result in increased sand usage for a given casting, even though the sand compact is generally supported in a box.

Excessive amounts of sand in the moulding system results in unnecessary capital and operating costs and should be avoided. A lower sand-to-liquid metal ratio will reduce the total volume of sand in the system and, therefore, reduce the consumption of new materials.



## 5.1 SAND-TO-LIQUID METAL RATIOS IN IRON FOUNDRIES

The distribution of sand-to-liquid metal ratios in the iron sector is shown in Fig 12. While the average sand-to-liquid metal ratio in this sector was 9:1, some foundries were operating either considerably above or below this figure. The lower ratios were generally associated with certain types of metal moulds or single-product foundries where box size/casting combinations were more easily optimised. The higher ratios were generally caused either by jobbing or short-run situations. Here, many widely varying casting configurations (and thus pattern configurations) were involved or the original product/product mix had changed significantly since the plant was designed.

Any iron foundry operating at the higher sand-to-liquid metal ratios should optimise its box size/casting combinations to reduce sand consumption.

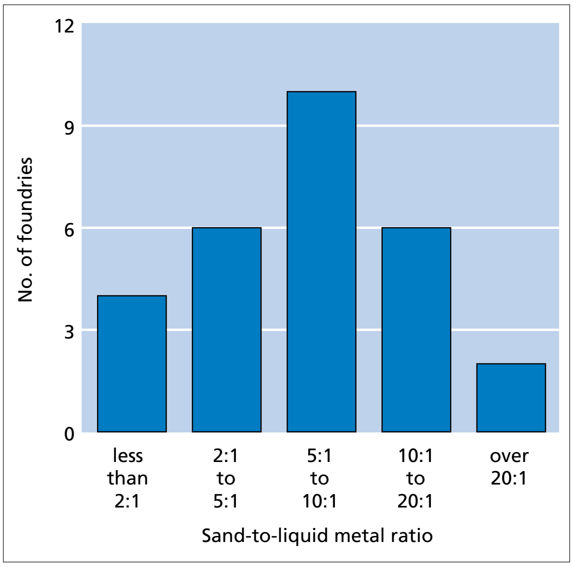



*Fig 12 Sand-to-liquid metal ratios in iron foundries*

## 5.2 SAND-TO-LIQUID METAL RATIOS IN COPPER FOUNDRIES

Fig 13 shows the distribution of total mixed sand-to-liquid metal ratios in the copper sector, where the average sand-to-liquid metal ratio was about 4:1. The reason this value is lower than that for the iron sector is largely because most copper foundries are product-orientated with an optimised box size.

The survey revealed that several foundries in this sector were, however, using very high sand-to-liquid metal ratios. In one foundry, this was due to a change in the product mix in recent years. Any foundry with a high sand-to-liquid metal ratio should review its processes with a view to reducing sand consumption.

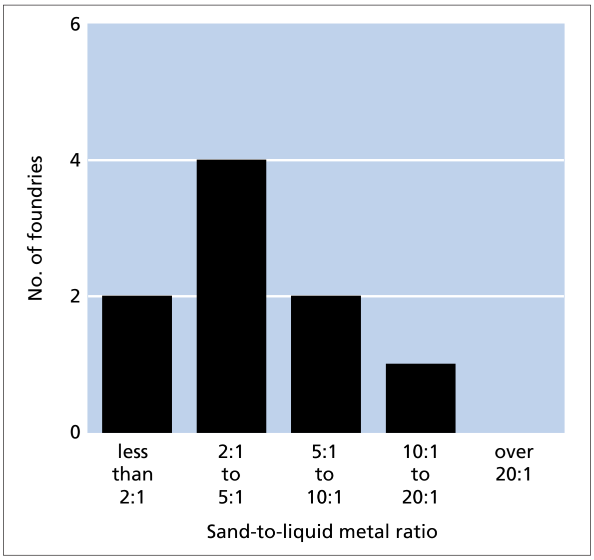



***Fig 13  Sand-to-liquid metal ratios in copper foundries***

section 5

# 6 USE OF BINDER SYSTEMS FOR COREMAKING

All greensand foundries use chemically bonded sands for coremaking. This is because chemically bonded sands offer the high degree of technical flexibility that is required for core production. In these cases, however, there is a need to manage the environmental issues associated with the binder systems used.

The survey revealed that many greensand foundries use several coremaking systems (see Fig 14). A small percentage of foundries do not use any cores, while others are using several distinct coremaking processes. Two or three binder systems will generally provide a foundry with the required degree of flexibility.

It is recommended that a foundry should carry out a review of its binder requirements if it uses two or more binder systems.

The use of multiple binder systems has several disadvantages:

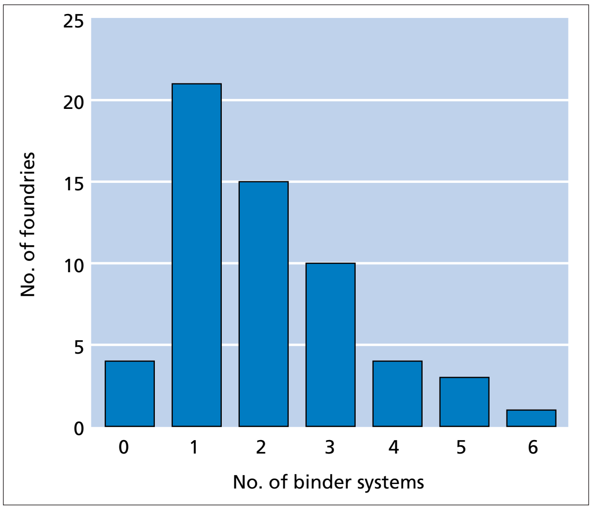



***Fig 14 Number of binder systems used for coremaking***

- there are extra training requirements;
- stock maintenance for each binder system ties up capital;
- premium prices are often paid for smaller quantities;
- extra documentation is required to comply with the quality assurance standards for each system.

The use of different binder types for coremaking in greensand foundries is considered in the Appendix.

# 7 METAL YIELD

Metal yield is the ratio of the amount of metal melted to the weight of the finished castings. Five main factors affect metal yield ie:

- quality requirement;
- choice of mould-box size;
- the extent of runner and feeder systems;
- metal shrinkage;
- scrap casting rate.

Metal yield does not have a direct effect on sand use. However, an increase in yield may result in fewer moulds being produced, which means that less sand is consumed overall.

Lower metal yields are generally associated with higher integrity products where superior quality standards may be required, necessitating a more extensive feeding system. Lower yields, however, may also be indicative of higher scrap rates and excessive feeding systems. In these circumstances foundries should review process control and mould production methods.

The average metal yields for the main alloy sectors are given in Table 4.

| Sector | | Average metal yield |
|---|---|---|
| Iron: | grey | 68% |
| | spheroidal graphite (SG) | 63% |
| Aluminium | | 57% |
| Copper | | 58% |

***Table 4 Average metal yields in the main alloy sectors***

section 7

A significant number of survey respondents declined to supply yield data, particularly in the aluminium and copper sectors. However, some general comments on metal yield can be made.

- The range of yields reported for grey iron and SG iron was from 40% to over 90%.
- Metal yields reported by aluminium foundries were fairly evenly distributed between 40% and 80%. Over 50% of aluminium foundries, however, chose not to supply data.
- Half the small number of copper foundries that supplied data are achieving yields of between 50% and 60%, though the reported range is 30% to over 90%.

# 8 WASTE SAND DISPOSAL

Waste sand management is becoming increasingly important to foundries because the cost of disposal to landfill has increased dramatically in recent years. This is primarily due to tighter legislative control of both waste sand disposal and waste disposal sites. Moreover, the landfill tax will further increase disposal charges.

Survey respondents reported waste sand disposal costs ranging from 'zero', where disposal is carried out at the foundry's own site, to over £20/t (see Fig 15); the average was £9.10/t. A similar cost distribution was obtained for the chemically bonded sand survey and so the data from the two surveys were combined to produce Fig 15. Over 50% of foundries reported waste sand disposal costs of between £5 and £10/t.

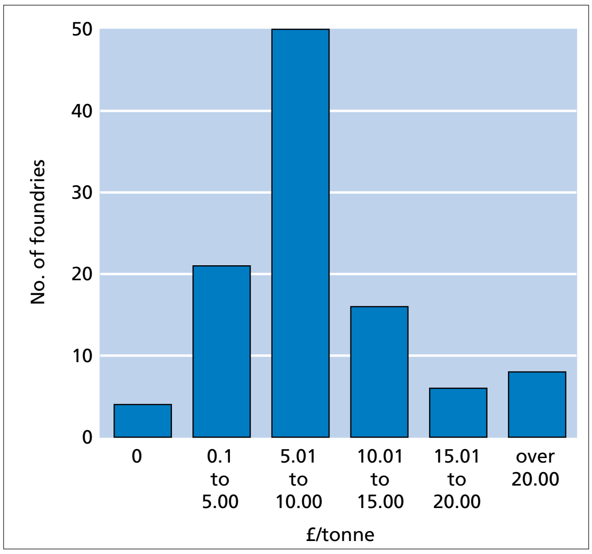



***Fig 15 Cost of waste sand disposal***

Foundries reporting 'zero' waste sand disposal costs may not fully appreciate the effects of recent environmental legislation; these foundries are urged to contact their local Waste Regulation Authority (WRA) or the ETBPP's Environmental Helpline on 0800 585794 for free advice. The new waste management licensing regime and other legislative changes have significantly increased the costs associated with the management of waste disposal sites. Moreover, the true cost of on-site waste disposal is often hidden, and not apparent to the foundry producing the waste.

As the spread in waste disposal costs was wider than expected, the data supplied by foundries were studied further to see if any one factor was critical. This showed that disposal costs for foundries close to landfill sites were similar to those for foundries where the sand is transported long distances. Some variation in the average disposal costs within different regions was found (see Table 5), but this was insufficient to account for the spread in costs noted in Fig 15.

| Region | Average disposal cost (£/tonne) |
|---|---|
| South | £10.50 |
| Midlands | £7.50 |
| North-east | £10.20 |
| North-west | £9.20 |
| Scotland | £5.80 |

***Table 5 Regional difference in sand disposal costs (1995 prices)***

Foundries are under ever-increasing economic pressure to reduce the amount of waste sand that is sent for disposal. Many foundries are starting to implement waste sand reduction strategies. However, foundries should consider developing a strategy to minimise waste from all processes.

# SAND ACTION PLAN

When developing a sand action plan in a greensand foundry, two basic areas should be considered:

- sand mix costs and use;
- used sand disposal/reclamation.

## 9.1 SAND MIX COSTS AND USE

The cost of the greensand base, silica sand, is governed mainly by the way in which the sand is packaged and transported to the foundry. Delivered silica sand costs may be halved by changing from bagged to bulk tanker deliveries. Even small foundries could benefit from installing a hopper to enable deliveries of new silica sand to be made by tanker.

Additive costs are significant, even in the relatively small quantities used in greensand foundries. It is therefore important that any additive is used in the most cost-effective manner.

The quality of sand at the greensand mixer should be checked regularly; either manually in small operations or using automatic sensors to check each mix in continuous operations.

A unit sand system uses less new sand than a facing sand/backing sand approach. It is worth considering changing to a unit sand system to reduce costs. However, steel foundries should review casting quality as well as mixed sand properties.

The use of improved working practices and techniques will allow better use of moulding box space, provide more efficient feeding systems and reduce scrap levels.

### ACTIONS TO REDUCE SAND COSTS

- Review purchasing contracts for sand and other greensand components.
- Review delivery/transport arrangements.
- Examine new sand addition rates and reduce to as low as possible, preferably less than 2%.
- Consider using a unit sand system to reduce consumption of new sand.
- For sand mixes, introduce a regular calibration regime for additive mixing equipment, supplemented by a regular sand testing programme.
- Train operators to keep strike-off sand to a minimum.
- Minimise sand-to-liquid metal ratios.
- Increase metal yield by improved methoding.
- Rationalise on binders for coremaking systems wherever possible.

## 9.2 USED SAND DISPOSAL/RECLAMATION

The survey revealed a wide variation in the quantity of new sand added to the mix. Reducing new sand addition rates reduces the amount of sand sent to landfill. As yet, no UK greensand foundry is using secondary reclamation. Secondary reclamation is, however, well-established in other countries.

### ACTIONS TO IMPROVE WASTE SAND MANAGEMENT

- Use the highest amount of reclaimed sand possible in the sand mix.
- Evaluate techniques for reclaiming greensand to new sand quality (where large volumes of spent sand are disposed of).

The above actions will maximise the amount of used sand which is reclaimed. For remaining waste sand, foundries should examine sand disposal costs and possible alternative disposal options.

# Appendix

# BINDER SYSTEMS USED IN COREMAKING IN GREENSAND FOUNDRIES

The various binder systems used in UK foundries have inherent advantages and disadvantages. An individual foundry should evaluate its needs to determine the most appropriate one or two system(s). A foundry using a number of binder systems is advised to review its coremaking requirements.

The use of different binder systems in greensand foundries in the iron, aluminium and copper sectors is shown in Figs A1 -A3.

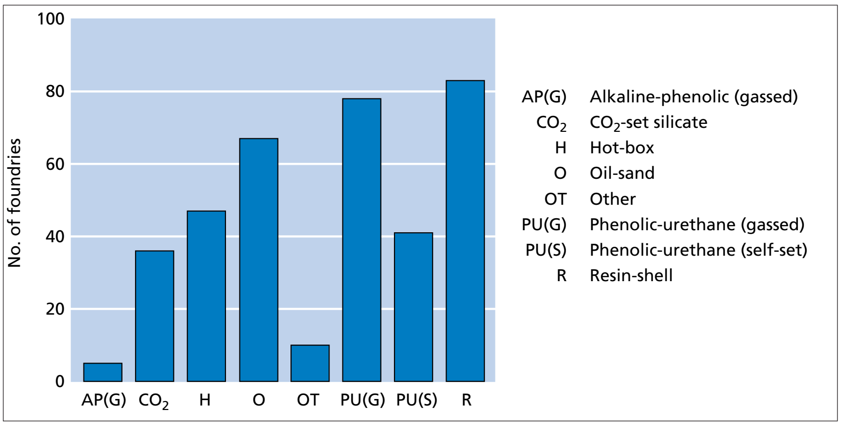



***Fig A1  Core binder systems used in iron foundries***

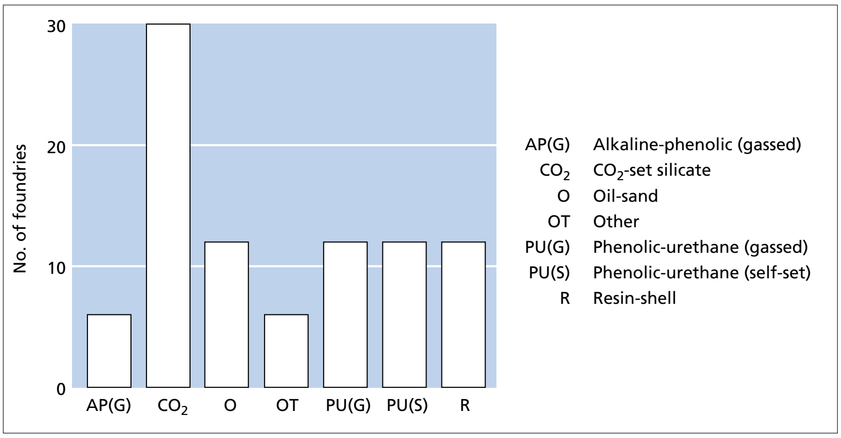



***Fig A2  Core binder systems used in aluminium foundries***

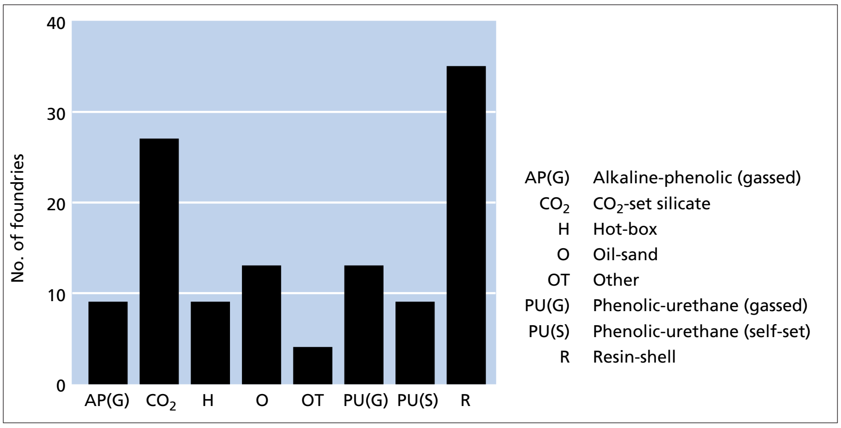



***Fig A3  Core binder systems used in copper foundries***