Odour Control Strategies for Modern Foundries: Part 2

Some Australian Examples

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Abstract

This paper follow on from the paper "Odour Control Strategies for Modern Foundries" by William D Scott and J Alexander Otte, Jr [1]. The Australian Standard for Odour Measurement and the implications of this standard for industry are discussed, together with some basic concepts of odour assessment.

A brief review of common odour control strategies in Australia is presented. Health risks and myths levelled at the foundry industry are touched on.

Three common conflict scenarios between foundries and their neighbours are discussed: change of process, change in the surrounding neighbourhood, and moving a foundry to an inappropriate location. These are illustrated by reference to selected Australian foundry case histories.

1. Introduction

The program of this Foundry Conference concentrates, quite properly, on subjects like metallurgy, binders, pattern making, staff training programs and manufacturing efficiency. Subjects like odour conflicts with neighbours, Environment Protection Authority regulations and licence requirements, and non-core projects to upgrade odour controls are not so prominent. Yet these issues can make a difference between a profit and a loss, continued operation of your foundry or forced closure. This paper raises these issues, refers to some of the case studies presented by Scott and Otte [1], and illustrates them using some local Australian examples.

2. Odour

2.1 What is Odour?

Much of the thinking about odour is carried on by consultants and academics. Industry mostly ignores the odour problem until their local Environment Protection Authority (EPA) forcibly brings it to their attention. In Australia, much of the work on odour is carried out by members of the Clean Air Society of Australia and New Zealand (CASANZ). This covers the sampling and measurement of odour, carrying out computer modelling to track odour movement and working out ways of minimising, dispersing or otherwise reducing the impact of odours from industrial or agricultural sources on surrounding residences or other sensitive receptors.

2.2 Odour Measurement

AS/NZS 4323.3:2001 [2] specifies how odour samples are to be analysed. Criteria for selection of a human panel, method of presenting odour samples to the panel, calculation of the odour concentration values are all specified.

The proclamation of this standard means that odour assessment is now uniform across Australia and New Zealand. In particular, it is now much easier to compare odour measurements undertaken in different States. Prior to AS/NZS 4323.3:2001 each State EPA had prescribed a different technique for measuring odour. Industries which operated across the country were in the position where identical odour producing processes were assessed as having different odour emission rates.

Another benefit of AS/NZS 4323.3 is an increased level of accuracy and repeatability in odour assessment. For example, the Victorian EPA Method B2 of assessing odour had an uncertainty range of ±50%, while the AS/NZS 4323.3 method has an uncertainty range of ±25%.

Sampling techniques are not yet prescribed by a standard, although discussions, led by members of CASANZ, are taking place to produce such a standard.

Odour criteria, which industry must achieve, still vary from State to State, and this has implications for design and separation distances for a range of industries which operate across State borders.

2.3 Subjective Odour Assessment – FIDOL

Odours are often characterised by the FIDOL scheme. This is an acronym standing for:

Frequency – how often do the odours occur?

Intensity – how strong are the odours? This can be approximated by odour concentration as measured under AS 4323.3, or assessed using the German Standard VDI 3882.

Duration – how long does each odour incident last? Weak odours which last for a long time are often more annoying then much stronger odours that last for a few minutes.

Offensiveness – Hydrogen Sulphide is offensive, as is mercaptan, but less offensive odours can still cause problems.

Location – if you are isolated from the nearest sensitive receptor, you can emit odours, but if you have expensive housing next to you, there will be trouble.

FIDOL forms a useful checklist for assessing your odour strategies. Generally, you have no control over the offensiveness of your odours if you are locked into a particular process, such as shell moulding instead of green sand moulding. Neither can you change your locality, although you should object to Council planning decisions to put up expensive high density apartments alongside your foundry. Frequency, intensity and duration of odour incidents can be changed or manipulated to achieve an overall reduction in odour impacts.

3. Odour Control Strategies

3.1 Extraction and Ventilation

Any extraction system must be designed for close capture of the emissions of concern. That is, the percentage efficiency of capture must be as high as possible. Efficient capture of emissions at source is the key to keeping extraction volumes down, which means smaller fans, smaller ducts, smaller baghouses and smaller power costs.

However, smaller fans, ducts, etc, are not efficient if you are capturing only a small percentage of emissions, and the majority of your emissions waft out your doors, windows, passive ridge vents, etc, as fugitive emissions. This is because fugitive emissions have a much greater impact on nearby neighbours than the same quantity of emissions exhausted through a tall stack.

3.2 Baghouses

Baghouses primarily remove particulate, from furnace, shakeout and fettling operations. Efficient close capture of emissions, combined with minimum extraction volumes of air means smaller baghouses can be used with consequent costing savings.

Baghouses do not remove odour from an exhaust stream. Table 1 shows that a baghouse may provide an averaging effect on odour concentration when there is variable number of odour sources feeding into a single baghouse. The data in Table 1 was collected from a baghouse treating fumes captured from two electric arc furnaces, when only one of the two was operating. It appears that the filter bags absorb a portion of odour when two furnaces are operating, which may be stripped out when only one furnace is operating, but the overall extraction air volume remains constant. That is air from the second non-operating furnace was still being extracted.

Table 1 Baghouse Effect on Odour Concentration
(One electric arc furnace out of two melting steel during sampling)

Location	Odour Units ($OU_{AS\ 4323}$)
Baghouse Inlet	120
Baghouse Outlet	180
Baghouse Inlet	76
Baghouse Outlet	85

3.3 Process Substitution

Of the various phenolic binders, it is sometimes stated that Phenolic Urethane binders produce more odours than other types. When odour problems arise, binder suppliers often suggest switching to another phenolic based binder. Reference to various case histories of foundry/neighbour conflicts suggests that there is little difference from the community viewpoint in odour emissions from different phenolic based binders, even though the chemical composition in the odour emissions may change.

Green sand binders do appear to emit less odours. In many foundries, this improvement is lost due to no extraction ventilation being provided for these lines. Any green sand foundry planning to add a phenolic binder line should evaluate their neighbourhood very carefully before implementing the proposal.

3.4 Chemical Scrubbers

Chemical scrubbers are not much used in Australian foundries. One system is the “Odorguard” system developed in the UK by Dr F Valentin in collaboration with ICI. This was successfully used in a UK foundry as reported by Hill [3] and is available in Australia. The Odorguard process is a single stage oxidation process using sodium hypochlorite and an oxidisation catalyst. The system works well, provided you have close capture of your odourous gas, but is relatively expensive to buy and to run. There are also ongoing management issues with waste water treatment and disposal of the scrubber liquid.

3.5 Thermal Oxidation (afterburner)

Fitting an afterburner to your exhaust stream, after close capture of all of the odours, will efficiently control odour. This is expensive to set up and to run and is generally not economically viable. It was EPA insistence on the use of this technology that was a contributing factor in the closure of the Hensley foundry in Adelaide in 2004.

3.6 Deodorising Perfumes – Essential Oils

This technology is used in a number of foundries, principally because it is less expensive than the control strategies summarised above. A recent paper by Fleer et al [4] summarised odour sampling results by three Australian Odour Consultants on six odourous industries which employed this technology. Odour sampling was carried out before and after the deodoriser treatment. In each case either minimal or nil reduction in source odour level was observed. Most of the trials were conducted under the direct control of the product supplier or according to the manufacturer's instructions.

3.7 Carbon Absorption

This technology is expensive to install and run. The carbon absorption is also chemically selective, and does not work efficiently for some chemical compounds.

4. Health Issues

Any industry producing odours is likely to generate complaints from the surrounding public. Often those who complain will allege that their health, or the health of their children is at risk. If it is known that the industry concerned does emit some of the compounds on an official government list, then such complaints on health risk are inevitable. Such lists of chemical compounds are usually published by State EPA organisations. Examples can be found in the South Australian EPA Guideline 386/03 [5] and the Victoria Government Gazette of 21 December 2001 [6].

The South Australian EPA has a mobile air quality sampling caravan which it deploys to areas where residents are complaining of health impacts from nearby industry. A number of foundries have had the benefit of this sampling in the vicinity of the nearest residential areas.

This caravan was deployed in 2001 about 100 m from the Hensley foundry (Adelaide), in a downwind direction favoured by light, stable southeasterly winds. The total deployment time of the caravan was five months, with continuous monitoring of a large range of chemicals for the last two months. The subsequent report [7] found that all compounds were well below State, National and International criteria which established that a health hazard existed. The South Australia Department of Human Services (ie Health Department) advised that health impacts would not be anticipated.

A similar exercise was carried out in November 2001 to March 2002 adjacent to the Cast Alloy foundry at North Plympton, Adelaide. The resulting report [8] found that all monitored chemicals were in concentrations well below State, National and International ambient air criteria and that health impacts would not be anticipated.

In September 2004, in response to residents complaints, the Environment Protection Authority announced that Hot Spot monitoring would be carried out at Kilburn, a northern suburb of Adelaide. One of the major industrial plants in the locality is a foundry, which is already experiencing odour complaints.

Few epidemiological studies have been carried out on the health of residents near foundries. Hill [3] quotes a study by the University of Southhampton (UK) who investigated the incidence of asthma and other chest complaints in children attending primary schools within 1 mile (1.6 km) of the Castings PLC foundry at Brownhills, West Midlands (UK). The results of this study were compared with results from a control group of children in Southhampton. The report found that there were slightly more symptoms in the Southhampton children than in the school children near the foundry.

5. Some Foundry Case Histories

5.1 Three Typical Conflict Scenarios for Foundries

Reading overseas foundry case histories and participating in some foundry incidents in South Australia indicates that there are three typical conflict scenarios between foundries and their residential neighbours. These arise from:

- Changes in casting process
- Changes in the surrounding locality
- Change in the foundry location.

5.2 Changes to the Casting Process

5.2.1 Pacific Steel Casting Company, Berkeley, CA (USA)

This case history is described by Scott and Otte [1] and by Chan [9], and will not be described here. This case is a classic case because it is typical of the community action group strategies to remove, or compel expensive capital improvements in, long-established industries from near their newly established houses at no cost to the residents.

The same scenarios has been repeated many times in many English-speaking countries, including two occasions here in Adelaide.

5.2.2 Castings PLC, Brownhills, West Midlands, UK

This foundry was a long-established foundry which produced malleable and ductile iron castings using green sand moulds.

In 1985, the company installed a new process line using shell moulds using phenolic urethane binders set by amine vapour. Almost immediately the neighbours started complaining of odours and adverse effects on health, leading to a Nuisance Order being served in November 1986. Hill [3] described the attempts of the foundry management to resolve these complaints over the next eight years. The various strategies included:

- Switching to a different phenolic binder from another supplier
- Hiring consultants to carry out odour measurements
- Hot-spot monitoring by the Local Authority
- Raising the existing exhaust stack from 18 m to 24 m, after lengthy negotiations with the Local Council to get Building Approval, which was granted on the condition that operating hours were restricted to 6 am to 10 pm.
- A legal appeal against the Council condition on operating hours
- An epidemiological study of school children at primary schools near the foundry by Southhampton University
- Measurements of individual chemical compounds in the exhaust stream
- Another Abatement Notice in 1991
- Installation of a chemical scrubber using the catalytic process trademarked as “Odorguard” in 1993

- Problems with particulate containing the scrubber catalyst required fitting a high efficiency filter prior to the scrubber
- Complaints continued, requiring more odour sampling, which indicated that the scrubber was still working effectively.

The above scenario is a typical one, with the exception that the foundry was still in business in 1996, eleven years after complaints started.

5.3 Changes in the Foundry Locality

5.3.1 Hensley Foundry – Torrensville, SA

The Hensley Foundry, previously Mason-Cox, was located on the banks of the Torrens River, which also formed the boundary between two Councils. The area was originally industrial, with brickworks and clay/shale quarries on the north and south banks of the Torrens River interspersed by industry of various types. The existing housing in the locality was mostly occupied by workers from the various industries. In the early 1990's, the clay deposits ran out, leading to the relocation of the brickworks.

The large clay pit immediately north of the Hensley Foundry was filled in at this time, and rezoned Residential in 1992, in spite of objections from the Environment Protection Authority, which foresaw the inevitable conflicts over odour. An upmarket medium density housing estate was subsequently built after filling in the clay pit. The nearest houses were about 180 m from the foundry.

A residents action group was soon formed to protest about foundry odour. This group was politically astute and subsequently, the Environment Protection Authority (EPA) served an Environment Protection Order (EPO) on the foundry in November 2000. The EPO was the result of several hundred complaints made to the EPA over the period 1999 to 2001 plus a new EPA metropolitan odour criteria which was formulated during legal argument between the foundry management and the EPA.

The major odour problems occurred during the evenings, after foundry operations had ceased for the day. Odours from cooling castings, plus the odour and fume accumulated in the foundry building during the day, were emitted from roof vents, broken windows, and gaps around doors, etc, as fugitive odours. As typical evening winds were light, stable southeasterly, these fugitive odours were carried, undispersed to the nearest houses to the west and northwest about 140 m away, leading to odour incidents of up to 2 hours.

Figure 1, taken from Purton [9], shows varying emissions with time after pouring until shakeout.

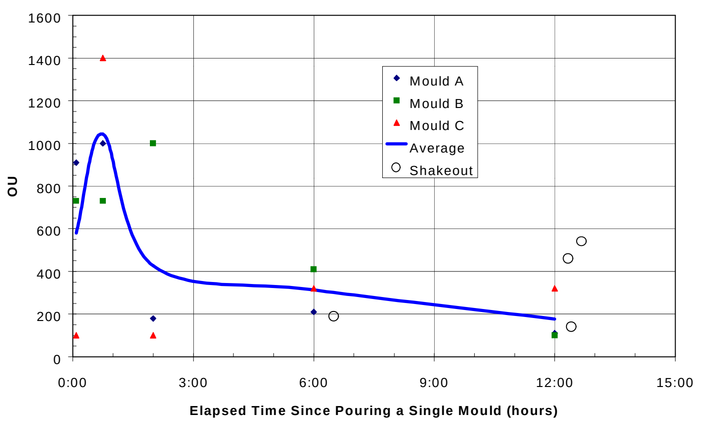

Figure 1 Odour Emission Rate Change From Time of Pouring

An initial engineering solution to the odour problem, based on close capture of odours, improved ventilation and stack extensions to 20 m was agreed between the EPA and Hensley. This was not proceeded with due to the Hensley management being unwilling to spend money. A subsequent prospective owner re-opened negotiations with the EPA, but found that the EPA had increased their requirements to include total capture of all emissions plus thermal oxidisation before discharge through stacks. The cost of this option was not economically achievable, and the foundry closed in April, 2004, putting more than 100 people out of work.

5.4 Moving to a New Location

5.4.1 A Small Brass Foundry in an Adelaide Hills Township

A long-established brass foundry spent its first 20 years near the town High School, and the following 20 years in a mixed Commercial/Residential area about 450 m from the local Council offices. The foundry then shifted to a new Industrial Zone on the fringe of the township, which was close to houses and a private school which was on rising ground to the south of the foundry. Complaints started not long after the new shell pouring line started operation. An unseasonable number of north winds ensured that odour emissions could be detected in the school grounds.

The school community quickly organised a very efficient political lobby group with well publicised demonstrations outside Parliament House, which resulted in the South Australian Premier visiting the site. Following stack testing, the Environment Protection Authority issued an Environment Protection Order which closed down the foundry at the new site, for an alleged breach of particulate discharge limits.

This was a case where the normal planning systems failed to anticipate the impact of moving an odourous industry into close proximity with a sensitive and environmentally aware community group. Both the local Council and State Government agencies failed to appreciate differences in microclimate between the old and new foundry sites, which were only about 1.5 km apart. These microclimatic differences worked against dispersion at the new site.

6. Conclusions

Foundries, particularly those foundries using the shell moulding process, will emit odour. The social tolerance of these odours has virtually disappeared over the past 20 years. The rise of the Environmental movement, and the strengthening of the powers of Environment Protection Authorities are imposing greater pressures on odourous industry than ever before.

Therefore, foundry management need to know much more about:

- What emissions are given off from their foundry
- Close capture of their emissions, and which emissions to concentrate on
- What treatment options are available at what cost
- The social changes around their foundry
- Changes in EPA odour policies.

Neglecting these issues can lead, in the worst scenario, to the forced closure of your foundry.

References

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