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ENVIRONMENTAL TECHNOLOGY BEST PRACTICE PROGRAMME

EMISSION-FREE MIXING CREATES A STIR

A GOOD PRACTICE CASE STUDY AT BASF COATINGS AND INKS LTD

GC34
FINAL RESULTS

This Case Study demonstrates the financial and environmental benefits of using the NIMIX system for mixing operations in automotive paint manufacture.

Following successful pilot-scale testing of the new mixing system, BASF Coatings and Inks (C&I) installed three 1 000 litre vessels for use in the final blending and mixing stages of automotive paint preparation. The technology uses a vibrating diaphragm located at the base of a sealed vessel to produce a mixing action that gently blends the coating material and solvent.

Examination of production records and batch monitoring at the Company confirmed the significant cost and other advantages of the mixing system. Enclosure of the mixing process means that volatile organic compound (VOC) emissions are virtually eliminated.

This Case Study at BASF C&I has demonstrated that the new mixing system provides many benefits, including:

- **Annual cost savings of at least £5 000**
- **Batch mixing times reduced by at least 50%**
- **No need for VOC abatement equipment**
- **Technology applicable to a wide range of mixing processes**

Paint Manufacture at BASF Coatings and Inks Ltd

The manufacturing process for a typical batch of automotive coating involves blending resin, organic solvent and tinted paste in a number of stages. Between stages, the batch is tested to:

- ensure a homogeneous mixture is achieved;
- monitor the batch for colour;
- determine the level of any further additions.

Paint manufacture can involve the use of multiple mixing vessels to prepare a variety of tinted paints to meet customer demand at any given time. BASF Coatings and Inks (C&I) has twenty-two 1 000 litre conventional mixing vessels at its Wolverhampton site. Conventional mixing systems consist of an open-top, stainless-steel vessel with hydraulically operated agitators that are lowered into the mixing vessel. During mixing, operators place specially fabricated lids around the agitator shaft, to enclose the mixing operation and to reduce batch losses due to volatile organic solvent evaporating from the vessel.

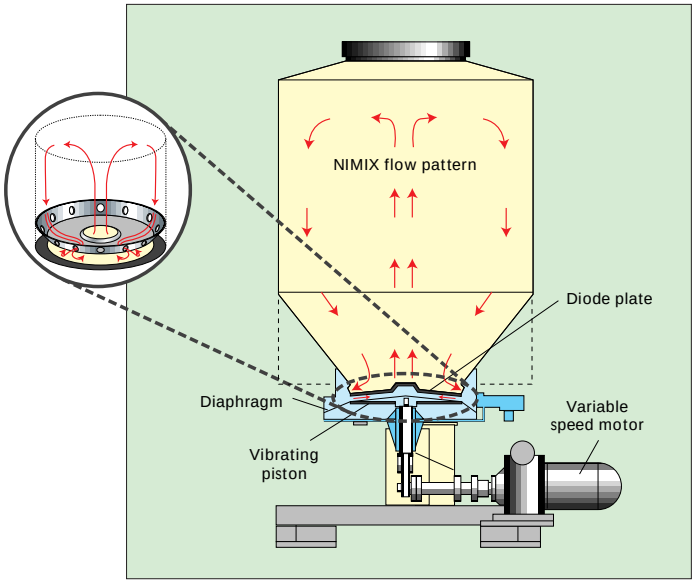
Conventional mixing techniques have a number of inherent problems, including:

- loss of solvent due to prolonged mixing;
- degradation within the batch;
- inefficient mixing due to the formation of vortices.

NIMIX Technology

The NIMIX mixing system blends the coating material and solvent by vibration rather than by stirring. At the base of the mixing vessel is a diode plate which has a number of specially-designed holes that are arranged to provide liquid flow within the vessel. The diode plate is positioned above a polymer-based diaphragm. During operation, the diaphragm is vibrated by a piston which is connected to a crank arm driven by a variable speed motor. The vibrating diaphragm causes liquid to move up through the central hole in the diode plate and down through the holes in the outer rim of the plate. This creates a bottom-to-top flow pattern within the mixing vessel, thus producing a stirring action. The lack of a shaft holding a stirrer or a paddle means that the coating and solvent can be gently blended in a completely sealed vessel.

Schematic diagram of mixing unit, showing flow pattern



Paint sampling during the final production stage

Batch Testing at BASF

Following two and a half years of pilot-scale tests, three 1 000 litre NIMIX vessels were installed at the BASF C&I site in May 1995, and were commissioned for batch production two months later. Although the new mixing system can perform the complete batch manufacturing operations, at present it is being used only for the final tinting and testing stages.

Batch details, eg batch history, raw material quantities, number of containers filled, are recorded on a production order paper (POP) for each batch. Mixing times for batches manufactured in the new mixing vessels are also recorded on the POP. Data were obtained from POPs for batches produced using the new and conventional vessels. Batch cycle times, labour costs, energy consumption and maintenance requirements were also compared.

Cost Savings

At BASF C&I, unit costs for each batch are calculated and take into account the manufacturing cost and raw material cost. The manufacturing unit cost is based on the batch size, batch cycle time, labour requirements and maintenance costs associated with the technology used. The unit sale price for a batch depends mainly on the tint used.

Labour requirements for conventional mixing and the new system have been shown to be similar. Maintenance requirements are also similar, but with one exception - the diaphragm in the new system may need replacing every 12 months. This can be carried out by the equipment supplier as part of a maintenance contract.

Table 1 Savings through improved yield with NIMIX

Batches processed in a year	22
Average weight of paint processed per batch	997 kg
Total amount of paint processed in one year	21 934 kg
Average yield loss: conventional	7.3%
Average yield loss: NIMIX	3%
Calculated weight of paint lost per year: conventional	1 600 kg
Calculated weight of paint lost per year: NIMIX	660 kg
Weight of paint saved per year	940 kg
Average paint selling price	£5.50/kg
Total savings in first year	[redacted]
Cost of installing three NIMIX mixers with one drive station per mixer	[redacted]
Payback for three vessels	approx 3 years

Direct cost savings are achieved through:

- improved yield of saleable paint;
- lower energy consumption;
- reduced mixing times.

Average yield losses are based on the losses from 42 batches produced in conventional mixers during the first six months of 1995, and 11 batches manufactured in the new mixers between July and December 1995; 22 batches/year are therefore assumed for the new mixers.

The calculated payback period of approximately three years is based on losses only; other savings, eg energy and avoided abatement costs, not included in this calculation would reduce this period. The use of NIMIX in additional mixing operations will further reduce the payback period and will increase benefits (see Table 1).

Energy Cost Savings

Additional cost savings are achieved through the reduced energy requirements of NIMIX mixers and the shorter mixing time. To quantify these energy cost savings, it is assumed that the energy requirement for a batch is equivalent to the specified motor requirement (see Table 2).

Table 2 Energy cost savings with NIMIX

	Conventional	NIMIX
Motor size	15 kW	2.2 kW
Mixing time/batch	10 hours	5 hours
Energy consumption/batch	150 kWh	11 kWh
No. of batches	22	22
Electricity cost	5p/kWh	5p/kWh
Total cost	£165	£12
Cost saving using NIMIX		**£153**

The NIMIX system has also led to a significant reduction in mixing time. The cost saving due to this has not been quantified because the mixing time required to produce a batch of the correct specification varies from batch to batch. Increased throughput is one of the many potential benefits of reduced mixing times.

BASF C&I expects to achieve further savings as more NIMIX mixers are installed and used for more operations in the paint-making process in complete batch operations.

Environmental and Other Benefits

Observations during the preparation of one batch of paint in a NIMIX mixer confirmed that solvent, and hence volatile organic compound (VOC) losses, could only be accounted for by residues left in the vessel and losses resulting from sampling and material transfers. The losses were not caused by the mixing process itself. By measuring yield loss and estimating process losses for the observed batch, it was found that the VOC releases from the NIMIX vessel were well below the limit of 1 kg over an eight-hour period as prescribed in the Secretary of State's Guidance Note PG6/10.

Major benefits of the new technology include:

- VOC emissions are well below prescribed limits, thus removing the need for expensive abatement equipment;
- dedicated local exhaust ventilation equipment is not required;
- lack of solvent odour and heat output from the mixers results in improved working conditions for operators;
- safety is improved because there is no rotating shaft/stirrer - a benefit proving very popular with operators.

BASF Coatings and Inks Ltd

BASF Coatings and Inks Ltd produces about 5 000 tonnes/year of automotive paints, container coatings and metal printing inks at its Wolverhampton site. The Company is part of the BASF Group and is a leading supplier of paints to the automotive industry. The Company employs 200 people at the site.

Comments from BASF Coatings and Inks Ltd

The Company operates in a highly competitive, specialised market where mixing technology for paint manufacture has been established for many years. The decision to invest in the new mixing technology was taken after extensive trials on actual batch mixes had demonstrated substantial cost savings and environmental benefits.

Even though we are currently using the new technology alongside conventional mixers, the real cost and environmental advantages offered by NIMIX are clear. The extent of these benefits will be fully realised once the technology is used for complete batch operations.

We are convinced that the new technology represents the future for paint mixing technology. The Company plans to replace nine of its existing conventional vessels with NIMIX mixers by the end of 1996. The new mixers will be suitable for the manufacture of complete batches. Further conventional vessels may be replaced in 1997.

The Wolverhampton site is the first in the BASF Group to use the new technology in batch operation and other parts of the group have expressed interest in the technology.

Mr D Chapman
Production Manager
BASF Coatings and Inks Ltd

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*There may be other suppliers of similar equipment. Please consult your trade directories or contact the Environmental Helpline which may be able to give you more details on request.

FOR FURTHER INFORMATION, PLEASE CONTACT THE ENVIRONMENTAL HELPLINE

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