Case Study

No 2: Microwave pre-heating epoxy resin saves $865,000 per year

During 2001, a major multinational chemical company in the Midwest (US) doubled production rates and made many processing savings in their resin heating line by using a 915 MHz cylindrical microwave heating system to pre-heat the resin.

The challenge was to pre-heat epoxy resin from 50 to 180°C prior to extrusion while maintaining a final product specification within acceptable quality ranges. Difficulties of conventional heating through a tubular heat exchanger include low volume throughput, high volumes of catalyst and wide ranging variation in final product quality. Also, frequent shut down of the production line due to solidification of the epoxy in the heat exchanger resulting from the lack of temperature control was a problem, as well as high maintenance costs resulting from the need to clean 61m of heat exchanger.

The solution was provided by Industrial Microwave Systems (IMS), who took 9 months from original R & D trials to the supply of commercial equipment. Installation and commissioning took less than 30 days. Operator training in use of the generator and control systems was accomplished in less than one week.

The installation comprises a 100 kW, 915 MHz Cylindrical Heating System. Figure 1 shows an equivalent system. The 130°C change in temperature was achieved in less than two seconds through a microwave exposure region of less than one metre resulting in an ideal, consistent final product quality.

Figure 1

The system uses a two stage elliptical heating applicator, shown in figure 2. Each applicator has a heating length of 30 cm, overall height of 61 cm and a diameter of 25 x 41 cm in the elliptical dimension. With interconnecting pipe work and wave guides, the overall height was 3 metres. The unit it replaced was a 61 m long, 5 cm diameter tubular heat exchanger with a steam heating jacket.

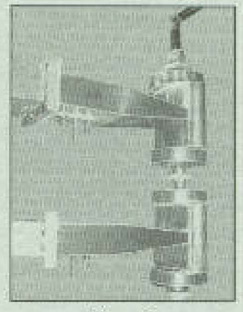

Figure 2

Process benefits were a doubling of throughput volumes, a four-fold reduction of production line shut-downs, and a ten-fold reduction in maintenance costs. The line achieved 98% absorption efficiency of the microwave energy generated and a total system efficiency of 83%. Uniform, volumetric microwave heating also eliminated clogging and the associated shut downs and maintenance.

The total annual value of the microwave heater is $865,200, based on the following value proposition:

1. Value of Throughput Increases. Additional capacity of 230 kg / hour generated 1360 tonnes additional product per year, worth $750,000 of Incremental Contribution Margin generated by the microwave heater alone.

2. Value of Catalyst Reduction. Normal operating mode catalyst consumption was 0.8 kg/hour. Catalyst consumption when employing the microwave heater was reduced to 0.6 kg/hour. Annual savings at 100% production capacity, at a catalyst cost of $11 / kg, are $57,600. As the microwave heater doubled production throughput, the annual saving doubled to $115,200.

The microwave power required to heat 550 kg / hour of resin is 42 kW of absorbed power. Allowing for microwave conversion and absorption efficiencies, the actual power required for this duty was 53 kW. Operating 24 hours/day for 50 weeks, 7 days a week and at an electricity

Case Study

continued from page 5

cost of 4.5 cents/kWh, the total power cost is \$20,034. The maintenance cost is \$1 per kWhr per magnetron or \$8,400 so the total annual operating cost is \$28,434.

Even if the steam heated tubular unit heating cost was \$10,000 per year, the annual downtime, loss of production due to change out of the exchanger and labour and materials involved in jack hammering the tubes plugged with solid resin cost at least \$100,000. Add to that the savings in catalyst, and the increased production as stated earlier, then the savings become even more significant.

The installed and commissioned capital cost of the microwave heating and control system was around US\$ 250,000. As a comparison, the shell and tube unit without steam boilers, installed steam train and control system was about \$100,000. So the payback on the capital investment was less than 3 months.

A company spokesman said of the installation: "After the microwave heater replaced the steam heated tubular unit, production rate doubled, downtime due to fouling was virtually eliminated and there were savings resulting from less use of catalyst in our formulation."

IMS's approach on successful applications of microwave heating is to focus on applications where the customer has a clear economic advantage in changing to microwave technology, and only invest efforts where the unique benefits of IMS's ability to create a uniform field of microwave energy are of benefit to the customer. Further details can be found on http://www.industrialmicrowave.com and thanks are due to David Parrott for supplying details for this case study.

John Bows, Unilever Research Colworth, UK

AMPERE Subscription Rates

Europe:	1 year £30.00
	2 years £50.00
Worldwide:	1 year £35.00
	2 years £60.00

Contact:
Dr Ricky Metaxas, Electricity Utilisation Group, St John's College, University of Cambridge, Cambridge CB2 1TP, UK
Tel: +44 1223 338646 Fax: +44 1223 764150
Email: acm33@cam.ac.uk
www2.eng.cam.ac.uk/~acm/eug.html
www.ampereeurope.org

NEWS & EVENTS

9th AMPERE International Conference on Microwave & HF Heating, Sept 2003, University of Loughborough

For more details contact:
Professor Jon Binner, IPTME, Loughborough University
Loughborough, Leicestershire LE12 3TU, UK
Tel: +44 1509 223162 Fax: +44 1509 223949
Email: J.Binner@lboro.ac.uk or visit the following address www.lboro.ac.uk/departments/iptme/research/ceramics/index.html. See also www.ampereeurope.org

Jon Binner and his team has just created the following website: http://www.lboro.ac.uk/departments/iptme/Ampere9/Index.html
which has many of the details relating to the conference. There is also a dedicated conference email address ampere9@lboro.ac.uk which is especially intended for handling any enquiries you might have. Anyone interested in exhibiting at the conference should contact the Loughborough team as soon as possible with respect to costs.

A CEM organised conference on Microwaves in Chemistry will be presented in association with the 4th Annual Florida Heterocyclic Conference, which will take place March 10-12, 2003 at the University of Florida in Gainesville.
The details are:
7-9 March, 2003, Gainesville, FL(USA) "1st International Microwaves in Chemistry Conference", Headquarters, CEM Corporation, PO Box 200, Matthews, NC 28106, USA
Tel: +(800)-726-331, Fax: +(704)-821-7015,
email: Doug.Ferguson@cem.com
website: http://www.cemsynthesis.com/html/mic_conf.htm

Correction to case study article in issue 34 on page 5, immediately after Figure 2 it should have read (missing text highlighted in red):

"To achieve an even heat distribution in the production unit, the applicator consisted of a multimode cavity with 6 coupling port applying microwave energy. Constant energy input zones were designed to avoid over-exposure (the 6 coupling ports can be switched in way that a 10kg or 200kg barrel can be heated rapidly and uniformly). Product-specific temperatures programmes were developed. On-line infrared cameras were installed to monitor the pack wall temperature as a process control measure."

Profuse apologies to John Bows from the Editor.

Your news and views are always welcome

Please write to the Editor:

Dr Ricky Metaxas
Electricity Utilisation Group
St John's College, University of Cambridge
Cambridge CB2 1TP, UK
Tel: +44 1223 338646 Fax: +44 1223 764150
Email: acm33@cam.ac.uk

www2.eng.cam.ac.uk/~acm/eug.html
www.ampereeurope.org