

Keeping it clean...

WATER TREATMENT

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Ever since a well-known Swedish furniture store was associated with the work of the artist Carl Larsson, his home town of Falun became world famous. Yet the town of Falun has an interesting industrial history of its own. It is the home of the world's oldest limited company, Stora Kopparberg AB.

Stora Kopparberg is a copper mining company. Copper has been mined in the area for over 600 years. The copper from Falun has typically been used as a wood preservative and it is this copper that gives Scandinavian wooden houses their distinctive colour. The copper mines of the Middle Ages were open cast but over the centuries mineshafts were dug and now the area is riddled with a mixture of active and disused copper mines.

Today's environmental requirements are much stricter than in the past when old mineshafts could be used for dumping chemical and other types of

waste. The result was that by the year 2000 the town's waste water, as well as the industrial waste, contained a significant cocktail of heavy metals and other contaminants. Sweden's laws dictate that all the local authority's actions are open to the public and so the performance of the water treatment works is automatically published on the Internet every hour. Heavy metals are difficult to handle at any time but with the realisation that any mishap is public information within the hour, Falun Kommun authority didn't want to take any chances. They chose the stability and trusted process control of Linux.

Falun Kommun opted for the proven ABACUS4 for their process control software. ABACUS4 is the latest version of the ABACUS process control software originally developed at the end of the 1960s. The first industrial installation of ABACUS

The Linux operating system is now being successfully used in industrial process plant control. In Sweden, Linux's capabilities as both a highly stable operating system and reliable ISP software prove ideal to meet an unusual requirement.

CASE STUDY

FALUN

A traditional
Swedish home.



was commissioned in 1971 and used Data General hardware which had ferrite cores for memory blocks. Each ferrite ring had the capacity of 1 bit and a large, heavy group of them were put together to make a memory block which added a massive 1K memory. In addition to memory faults we know about these days, corrosion of the ferrite rings was an extra consideration. The last ferrite core based ABACUS control system still running was finally replaced in 1998 on a paper mill in the UK having running without fault for 27 years. During the 1970s the software was further developed and ported to DEC PDP 11 series hardware running on the RSX operating system on which it was renamed ABACUS II. In this form the system became widely used in boiler houses, paper plants, the steel industry, chemical and pharmaceutical production as well as other applications. At the beginning of 1990 the software was again ported – this time to DEC's VAX range of computers from where it went on to be available on the famous DEC MicroVAX range of computers. In 1997 the ABACUS process control software was ported over to PC hardware running on the Slackware distribution of Linux on

which it has continued to run for all industrial applications. Based upon Linux, it is now known as ABACUS4. It has been successfully run on the Red Hat distribution in the laboratory but in industry it is currently run on Slackware 7. Details of the ABACUS4 software can be found on www.abacus4.com

The waste water treatment process Falun Kommun chose was a High Density Sludge (HDS) process instead of the old-fashioned method of just neutralising the acid mine drainage water by addition of lime. The HDS-process can be designed in different ways, but the main point is that you recycle the sludge in the process, which results in getting a very dense and easily dewatered sludge. This product is later dried on the site before disposal, thereby minimising the volume of sludge to be disposed of.

In the two first steps in the HDS process in Falun the acid mine drainage water is mixed in rapid mixing tanks with sludge to adjust the pH to pH 4.3 in tank one and then again to around pH 6.0 in tank two. The second, third and fourth tanks are all aerated by membrane aerators. In the third tank lime is added take the pH to pH 8.3. The fourth tank has been installed in order to ensure stable products (sludge and water) out of the process. The change in pH between tank three and tank four should be minimal to ensure complete oxidation of ferrous iron and stability of the sludge.

The quality of the contaminated acid mine drainage water in Falun varies, not only according to the season, but also from which depth in the mine you pump it. The main ingredients in the water are sulphur, ferrous iron and zinc. pH for this contaminated water varies between 2.5 and 4.0, so it is normally highly acidic.

Due to the fact that almost all the iron exists in the ferrous form it is very important with efficient aeration to get all the iron oxidized into ferric iron.

The old mine buildings
are painted with copper
paint – the traditional
copper mines product.



If this procedure was not carried out, the sludge and the water would not be in a stable condition when they left the treatment plant.

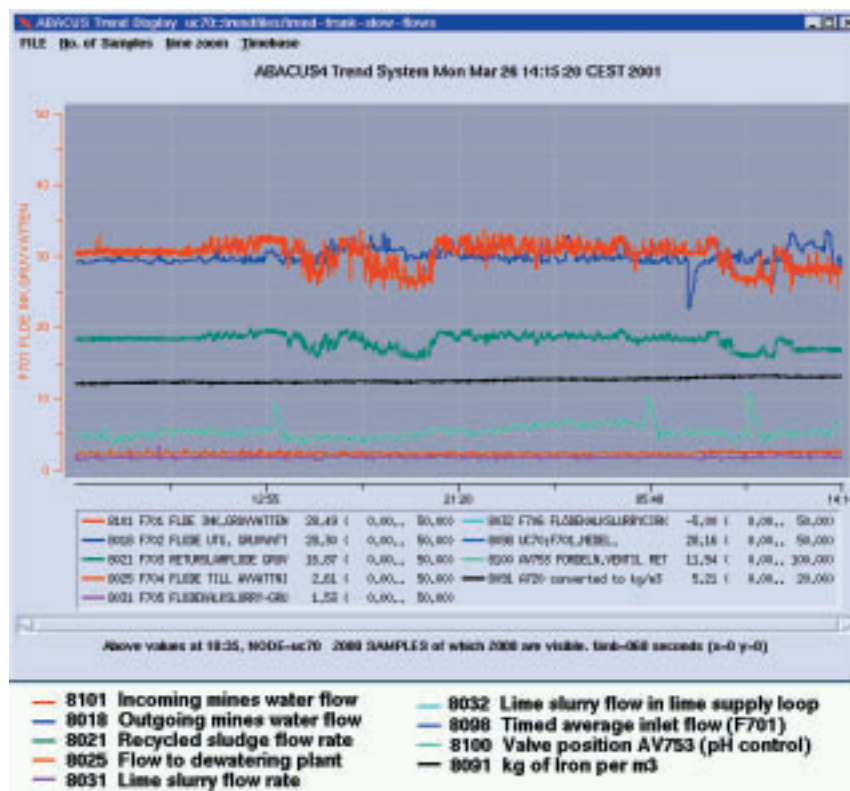
From the treatment plant in Falun a 99.9% reduction of the content of iron and zinc in the acid mines drainage water and a stable sludge with 55-60% solids is achieved.

The ABACUS4 process control system uses high quality standard industrial input/output (I/O) units for the digital and analogue I/O. A number of industrial standard protocols are available in ABACUS4 and for Falun Profibus communications was chosen giving up-to-date Fieldbus technology around the site. Process control decisions are then taken within the PCs running the ABACUS4 software on the Linux Slackware platform. The data, running conditions, alarms and reports are presented to the operators on PC-based operator workstations running ABACUS4 on the process plant network.

The UK and Ireland firm Rowan House Limited was involved in the process control site. Being chemical engineers, they advised and assisted MCH Konsulting in Sweden on the process control techniques to be applied to the process using Abacus4, <http://www.rowanhouse.co.uk/>.

The control of the process had to overcome significant problems. Each step of the process has to be adjusted to respond to changes in the dissolved heavy metal content and composition but, as with most water treatment processes, the time delays are significant. A truly distributed process control system (DCS) was used and configured to maximise the reliability and availability of the system for optimum safety. The selection of a DCS also facilitated optimum response to process changes. The use of Abacus4 enabled the alarm reporting and operator interfaces to also be distributed rather than needing to rely on a central computer. A central computer for the display of information and alarm reporting would have run the risk of failing to report process alarm conditions in the unusual event that it was offline for any reason. Since the plant performance is public information every hour, the operators need to know that they can always see what is happening even if one of the computers is offline for maintenance or software changes.

The water treatment site is often unmanned. Alongside distributed alarm handling, the Abacus4 control system makes use of the telephones. SMS text messaging is used to allow critical alarms to be sent as text messages to the duty operator's mobile phone whilst the site is unmanned. If the duty operator fails to reply to the Abacus4 system the message is also sent to other operators on the duty list. The text messages are followed by a pre-recorded voice message being transmitted by the Abacus4 DCS by telephone until someone responds to the alarm. These back up alarm systems are essential because the performance of the plant is being automatically displayed on a website by the Abacus4 DCS every



hour for public information. The result of failure to respond to an alarm would become well known throughout the town in a short space of time. Which is an excellent incentive.

Basic plant performance data is automatically posted on a website in compliance with Sweden's tough anti-secrecy laws. The performance can be seen by anyone logged onto the town's intranet. Falun Kommun's intranet is permanently linked to the Internet, allowing high-speed Internet access to everyone in the town. The performance of the town's waste water treatment can also be seen from anywhere in the world on: <http://www.users.wineasy.se/bbab/framby-reports/>.

Information available from the Abacus4 system.

Abacus4 control system view.

