

Lead recycling with flow-controlled compressed air station

Low-pressure Turbos Save EUR 600,000 Yearly

With a new low-pressure compressed air station where six variable speed, oil-free centrifugal compressors operate, the lead works of Weser-Metall GmbH in Nordenham, Germany saves up to EUR 600,000 in energy costs. The compressor installation is distinguished by technical control finesse: the control unit uses volume flow as the reference variable and not pressure, which is typically the case.

ESSEN/NORDENHAM, GERMANY, May 2009 “We save EUR 500,000 to 600,000 on energy costs per year with our new compressed air station”, said Timo Tesch. As manager of design/process engineering/ancillary operations at Weser-Metall GmbH in Nordenham, he is also responsible for new construction of the compressed air supply. Weser-Metall specializes in recycling lead, especially from battery scrap and battery paste. The highlight of the compressed air station, with a total of six new oil-free low-pressure centrifugal compressors of variable speed design ZB VSD (variable speed drive) from Atlas Copco, is their operational mode. Instead of being pressure-controlled, as is normally the case, they are flow controlled, and this is done at a range between 1500 and 10,000 Nm³ (standard cubic meters) per hour with up to 1.95 bar excess operating pressure.



Fig. 1: The container with the six compressors arranged right next to each other was designed especially for Weser-Metall by the project department at Atlas Copco. At the end, the complete “machine house” was brought in through the building covering with a crane.

Low-Pressure Air Around the Clock

The air from the turbos is needed in the lead works for three shifts, around the clock, as process and after-burning air. The process air is blown together with natural gas and oxygen through a lance immersed in the molten mass, maintaining the metallurgic process in the immersion melting furnace. Parallel to this, after-burning air is fed into the furnace via the molten bath to ensure that no reactive components, such as non-combusted natural gas, end up in the exhaust. The fact that the ZB turbos provide oil-free compressed air is not necessary from a technical process perspective, Timo Tesch said, “but this is definitely a pleasant side effect.”

When the Nordenham lead works converted from the coke-fired melting shaft furnace process to the more environmentally-friendly natural gas-fired immersion melting furnace process in 1996, a two-stage turbo compressor (first stage 0.82 bar; second stage 2.8 bar) was installed for

processing and after-burning air. It was always a little oversized right from the start, Timo Tesch said, and showed over time that it was a “genuine energy-destroying machine” that was regulated using a blow-off valve. “Finally, the rise in energy costs and the increasing age of the existing compressor had exceeded our pain threshold”, Tesch complained. “We knew there were better technologies for creating compressed air.”



Fig. 3: Weser-Metall General Manager Dr. Reimund Westphal (left) and Dr. Jens Manthey, responsible for the environmental protection initiative “Metalle pro Klima” at Recylex, are pleased about the 3700 tons of CO₂ which will be saved yearly with the new compressor stations.

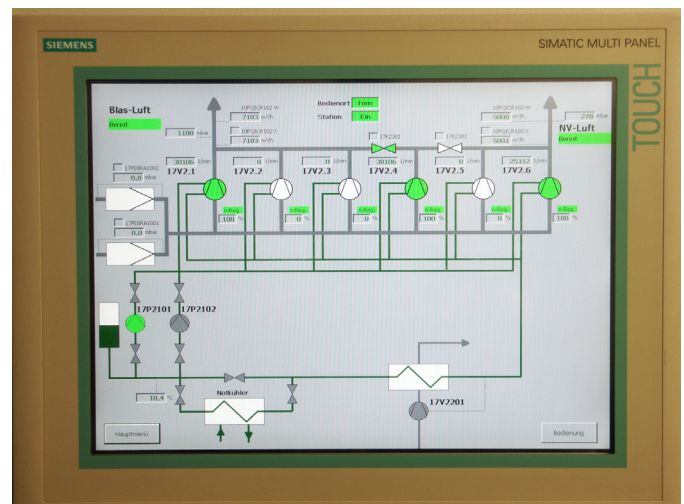


Fig. 4: Monitor of the central control unit with a schematic representation of the compressed air station and the operating conditions of the compressor modules.



Fig. 5: Logistical master achievement: two cranes working together in order to bring in the complete compressed air station in their container-like housing through the building covering onto a platform at a height of 14 m above the old compressor installation.

Flow Regulation Is a Must

In the end, the best choice for this purpose was the brand new ZB centrifugal compressors with VSD direct drive from Atlas Copco. The problem for Weser-Metall was the lack of any references for those kinds of applications. Although ZB turbos were used in wastewater treatment plants, they were always pressure-controlled and not flow-controlled. “Our requirements are totally different”, Timo Tesch emphasized, and gave a brief explanation of the processes in the immersion melting furnace. The lance is immersed in the furnace in the liquid slag, which has a variable consistency. The colder it is, the stiffer it is. The lance will also deteriorate, resulting in variation in immersion depth. This and other effects cause the counter pressure to fluctuate at the tip of the lance. “In order to keep the metallurgic process securely under control, it is absolutely necessary for us that we can securely provide a specific constant volume flow at any time”, Tesch said, “also and precisely when operating conditions change very quickly.” Therefore, the operator constantly monitoring the metallurgic process in a control room must intervene and readjust the volume flow. This can be several times per hour or once a day, but when it happens, it must happen quickly. In certain circumstances, the volume flow can change suddenly up or down by up to 3000 Nm³.

Pioneering Role Thanks to Taking a Risk

Despite the lack of references for the ZB turbos, the decision was made to use this new technology Timo Tesch said, as he saw these variable speed low pressure compressors as the best options by far for saving power. “Being a pioneer sometimes means taking risks as well.” That was shared with Atlas Copco. The project engineers from Essen worked together with the Weser-Metall management to develop the design for constructing the new compressed air station. The greatest challenge was to use volume flow rather than pressure as the reference variable for controlling the compressors, Tesch emphasized. The decision was taken to link the higher level, self-sufficient control unit functioning as an isolated application of the individual compressed air station with the electronic control units of the individual compressor modules, so that they would operate and communicate with each other smoothly. The highest priority in all operating conditions should be to aim for the optimal energetic operating point. To do this, the individual modules must switch on and off at the right time, and in an

intelligent way. “This was all a very complex matter, and it took time to finalize the configuration that you see now”, Timo Tesch said.

Higher Level Control

The result is the present compressed air station with exclusively speed-controlled operating compressors. The process air is now provided by four turbos of type ZB 160, each with a maximum volume flow of 3350 Nm³ and up to 1.95 bar overpressure; the after-burning air comes from two ZB 100 VSD turbos, each can provide a flow of up to 4650 Nm³ and a maximum overpressure of 0.8 bar. The interaction of the turbos is regulated by a higher level control unit which also ensures balanced operation of the machines and is connected to the process guidance system of the immersion melting furnace. “The control software from Atlas Copco is excellent. All data from the compressed air system can be easily read out and visualized”, Tesch said. The option for evaluating measurement values and the curve representation with the Siemens-PC-S7 control unit are particularly outstanding.

When asked about the greatest benefits the new ZB compressors offer compared to the previous installation, which are (still) installed as an emergency reserve, Timo Tesch named the following four points most important to him: (1) the drastic energy savings, (2) the compact modular construction of the entire installation, (3) the low-wear oil-free operation of the compressors, and (4) their low noise level.

With regard to 1, the energy savings referred to above are EUR 500,000 to 600,000 yearly. “We consider it important that we don’t pointlessly blow off any compressed air, as that wastes a lot of energy and money. Instead all the air we produce should go into the furnace and be used there”, Tesch emphasized. This also includes the fact that the ZB turbos can completely shut off when the immersion melting furnace is stopped for an hour, once a day on average, when the lance is changed. “The old turbo compressor had to be left running, because we often had problems getting it to run again after the stoppage.”

With regard to 2, the compact modular construction, all six ZB turbos are installed together as a complete compressed air station in a container-like housing, which was installed on a platform at a height of 14 m above the old compressor installation. Tesch said “The new compressed air station only needs about half the volume of the old turbo compressor.” The



Fig. 6: An employee of Weser-Metall measures the temperature at the slag tick of the immersion melting furnace.

compact new installation could be installed within one day, because the entire compressed air container (conceived and developed by the Atlas-Copco project engineers for Weser-Metall) was prefabricated on a neighboring property, complete with all internal piping and cables. The container only needed to be moved by crane to its installation location and linked up there to the pre-prepared connections. Modular construction is also advantageous when it comes to redundancy. According to Tesch “Even if one or two modules should fail, we can still keep the immersion melting furnace operating normally.”

With regard to 3, the ZB turbos have wear-free, and absolutely oil-free magnetic bearings. There is no gear, because the turbo impeller sits directly on the shaft of the high-speed permanent magnet motor. Because this direct drive has no loss due to bearing friction, it has the best specific input power and very high efficiency compared to similar devices. The machines operate wear-free with this design which keeps the maintenance costs low. This is because there is no accident-sensitive inlet guide vane unit to regulate flow, which also requires intensive maintenance. Like all ZB machines, the machine is regulated exclusively using speed. A pleasant side effect of this drive design is that it no longer requires lubricant, so that oil cannot get into the compressor and contaminate the air.

With regard to 4, the low noise levels, a compressor that does not make noise is not possible; however, at 67 dB(A) for a ZB 100 VSD for example, the new turbos are so quiet, that a conversation can be carried on underneath the compressed air container. “You could not make yourself understood next to the old installation,” Timo Tesch said.

Looking forward, Tesch said that they are planning to disassemble the old two-stage centrifugal compressors in the near future. The time will come when it will be difficult to source spare parts, and the regular test runs would no longer be required, which are currently meant to guarantee the operational readiness of the old turbos in an emergency.

A Pilot Installation With a Happy Ending

Tesch’s summary was “The new compressed air installation is now so flexible, powerful, and user friendly, that they have met our, admittedly, high demands. As far as I am aware, this kind of installation is unique worldwide.” Both sides, Weser-Metall and Atlas Copco, took a big risk in breaking new ground. Of course there were dry spells along the way, “that cannot be avoided in a project like this”. However, the ending was a happy one, and all parties involved can be proud of that. “And the pleasure of constructing a pilot installation like this is priceless anyway”, Timo Tesch chuckled.

About Weser-Metall GmbH

Weser-Metall, part of the Recyclex Group, celebrated its one hundredth birthday in 2006, and today it specializes in recycling lead, especially from battery scrap and battery paste. Environmental topics are especially sensitive in this sector. Under the banner “Metalle pro Klima” (Metals pro Climate), Weser-Metall is announcing an environmental protection initiative of the non-iron metal industry (www.metalleproklima.de), which corresponds to a reduction in carbon dioxide emissions of 3700 tons per year just from energy savings through the new compressors.

In Nordenham, approximately 250 employees produce over 100,000 tons of lead (fine, soft, and copper cable lead) and lead alloys yearly for technical applications and by-products.

This gives the company the leading position in the European lead-producing industry. The majority of the lead is processed further for starter batteries for the automobile industry. Other consumers include the chemical industry, cable manufacturers, semi-finished product industry, apparatus engineering, raw material industry and ship construction.

As one of the most modern recycling companies in the lead sector, Weser-Metall uses 70% lead-containing secondary raw materials (auto batteries, etc.) and only 30% concentrates. The Nordenham works is considered a central lead plant within the Recyclex Group, as it processes rebuilt battery types originating from group business in Villefranche-sur-Saone, and Escaudoeuvres (both in France) and Goslar-Oker in Germany. Part of the lead business area at Recyclex includes a smelting plant in Brussels where lead alloys are produced in particular.

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