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Twin air compressor for energy saving and back up capability

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Abstract

Since the first Pot Tending Machine commissioned by ECL™ 50 years ago, all the new options, tools and technical solutions have been conceived and designed only to meet with smelters' challenges: reduce energy consumption and consequently allow significant cost savings and ensure safe and secure operations.
In close collaboration with MATTEI, a world-class air compressor designer and manufacturer, ECL™ has then developed and equipped its Pot Tending Machine with a new standard of air compressor: the twin air compressor. Instead of just one big energy-intensive compressor, two smaller and lighter compressors are in most cases used separately (anode changes), except for tapping operation. By running them alternately at only 82% of their full capacity, there are definite energy savings with the additional benefit of a longer operational life for the compressor. Furthermore, the size and weight of this new standard greatly ease maintenance operations.

Introduction

The smelting process required to produce aluminium from the alumina is continuous. The potline is usually kept in production 24 hours a day year-round. The immense amount of power required to produce aluminium is the reason why aluminium plants are almost always located in areas where affordable electrical power is readily available. The electrical costs constitute the main and considerable first expenditure for smelters. What about an efficient technical solution to reduce energy consumption and consequently allow significant savings?

Context

As a brief reminder of the aluminium production process: many different operations on the electrolysis cells are essential to produce metal in the pots. These operations can be grouped into two categories: on one hand operations related with anode changing and on another hand the ones related with tapping operation. The first category includes operations such as single or double anode extraction, anode hole cleaning, crust breaking, anode positioning and gauging. The second one, operations allowing to suck liquid aluminium from the pot in a ladle through a tapping tube.

Nowadays in modern smelters both are essentially performed by the different tools of the Pot Tending Machine (PTM). It's indeed far more advantageous, simplest and quicker to have the tapping assembly grouped together (ladle, tapping tube and vacuum device) and embarked directly on the PTM than independent devices such as vehicle on the ground (use of short and light cables and hoses versus long and heavy ones for ground method). All the tools are generally actuated pneumatically or hydraulically.

Note also that the tapping function only represents approximately a quarter of the operating time of a PTM designed to independently carry out both function.

The compressed air required to create the partial vacuum in the ladle can be provided by a fixed air intake in the building, typically the air intake nearest to the cell on which tapping is carried out, but it can also be provided by the compressed air source of the PTM.

Initially, the PTM whose only purpose was to ensure anode handling operations was equipped with a regular capacity single compressor compatible with the standards of the market, enough to perform the functions related to these operations as well as some permanent functions that do not consume great amounts of compressed air.
When the tapping assembly became fully part of the PTM, it was imperative to equip it with a high power on-board compressor. This big and expensive compressor was designed according to the compressed air flow requirement for tapping operations, which is in fact much higher than the air flow requirement for most other operations, in particular those related with anode handling, consuming significantly less compressed air.
As already mentioned, the tapping operation represents only ¼ of the operating time of the PTM. Consequently the high power compressor is operating very much below capacity for 75% of the time that it is in use. Moreover using it at a lower output not only led to unnecessary energy consumption but also unnecessarily deteriorates the properties of the lubrication oils, causing practically as much wear to the mechanical components as if the compressor had run at full capacity for 100% of the time.

Based on this analysis, ECL™ along with MATTEI sought to develop a solution to have a PTM that consumes as little energy as possible and requiring as low frequency of maintenance work as possible, while being perfectly suited for both anode changing and tapping operations.

The dual air compressor solution

In place of a large, cumbersome compressor that used a lot of energy even at low power, ECL™ equipped the PTM with two smaller and lower capacity compressor: a first one designed for operations other than tapping, a second one designed to provide the extra compressed air necessary during tapping. They operate in tandem.

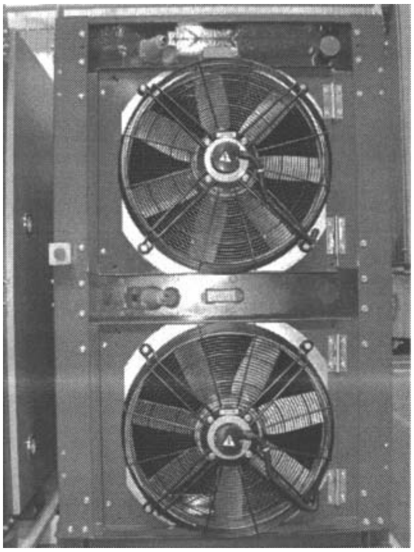

Figure 1 ECL™ Twin air compressor

Or they work independently of each other during anode operation phases or they operate together and the sum of the air flows allows the creation of a partial vacuum in the ladle during tapping. One air compressor provides compressed air used to operate the tools at a minimal output ranging between 4000 to 8000 liters per minute, depending on the number of tools of the PTM to be activated, at a pressure of 7 bars while the other compressor is stopped (no energy consumption)
For the tapping operation, the compressed air must be provided at a high enough flow rate so as to the liquid aluminium can be sucked and transported to the ladle but also low enough to avoid sucking electrolyte bath along with the liquid aluminium.
On this basis and because an empty ladle requires a much larger consumption of compressed air than a ladle already filled with the melt from the two first cells, the second compressors has to be able to assist the first one by providing compressed air at a minium output of 13 000 liters per minute.

Master/slave method for even more cost savings

The two compressors are identical and then interchangeable. They are able to provide the same minimum flow of compressed air at the same pressure. So during normal use phases they operate alternatively in order to distribute the operating time between them in a substantially equal manner, with the result that the time between two maintenance operations could be greatly increased, to almost double. The time between two maintenance operations on both compressors is higher by about 60% than the time between two maintenance operations on one high power compressor. The reduction in maintenance frequency not only leads to a reduction in the number of times the compressor has to be drained for continued performance, a fall in oil consumption and a saving in terms of staff downtime, but also improves the availability rate of the PTM.

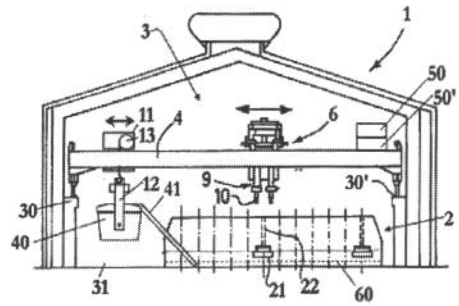

Figure 2 Location of the twin air compressor

1: Electrolysis hall	12: swing bar
2: Electrolysis cells	40: laddle
3: PTM	41: tapping tube
31: aisle	50 & 50': twin air compressor
21: anodes	30 & 30': gantry track
22: tige	10: tool
4: overhead traveling crane	9: telescopic arm
6: tool trolley	60: line
13: tapping winch	
11: carriage	

Extra advantages

The compressors are smaller and correspond to the standards of the market, resulting in a lower acquisition cost from the fact that they are produced in large quantities. Plus the cost of installing several compressors is not higher than only juste one large size compressors. Moreover, as the compressors are chosen from market standards, it is easier to obtain spare parts and maintenance is consequently greatly facilitated.

Another advantage already mentioned lies in the fact that tha availability of the PTM for operations other than tapping is greatly improved: in the event of a breakdown of one of the compressors, the other one still can operate during anode changing operations.

A well designed and made tool

An electrolysis hall offers a hostile and noisy environment where solid particles of alumina and carbon escape from the cells and where temperature can reach very low level (about -30°C) or very high one (about 70°C) depending on the aluminium production site.
To keep the compressors at their maximum efficiency, ECL™ and MATTEI equipped the compressors with some indispensable features. Installed one above the other on the beam in order to lower spatial requirement, both compressors are equipped with a more efficient cooling system than the one on the high power compressor. The compressors are also provided with a filtration system to keep them free from dust, an acoustic insulation and a temperature control.

Conclusion

Yearly, thanks to the twin air compressor, 115 000 kWh and 2800 $ can be saved for just one PTM! Just do the math for the whole machine base of a regular plant (9 PTM). It's good for the plants' pockets but also for environment (340 tons of CO^2).

Acknowledgement

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