Storvik HAL Compactor

Gunnar T. Gravem[1], Amund Bjerkholt[2], Dag Herman Andersen[3]
1. Position, Senior Vice President, Storvik AS, Sunndalsoera, Norway
2. Position, Managing Director, Heggset Engineering AS, Kristiansund, Norway
3. Position, PhD, Hydro Aluminium AS, Årdal, Norway
Corresponding author: gunnar.gravem@storvik.no

Abstract

The vibrocompactor is the main component in the forming stage of the green anode in the paste plant. The paste for an anode is densified in the vibrocompactor by dynamic and static mechanical forces during a time period less than a minute. The paper describes the different functionalities of the compactor and also different potentials it has for anode production capacity and quality in the future. The HAL vibrocompactor has been developed since 1959 and today the input of dynamic force is integrated to the cover weight (the vibrating mass on top of the anode paste). This results in more effective vibration and short vibration time. The feeding of paste is done from 2 hoppers in stationary position with minimal filling time of the mould. Production capacity is 36 anodes/hour at 22 s vibration time. The compactor has few movable parts and the maintenance and operation cost is very low. Availability factor is measured to 99,5% over 5 years.

Keywords: Anode forming, high effectivity, low maintenance cost, high availability factor

1. Introduction

The vibrocompactor is the main component in the forming stage of the green anode in the paste plant. The paste for an anode is compressed in the vibrocompactor by dynamic and static mechanical forces during a time period less than a minute. The report describes the different functionalities of the compactor and also different potentials for increased anode capacity and quality in the future.

In the period 1959-1975 was the basic principles for the HAL vibrocompactor developed where the input dynamic force was integrated to the cover weight (the vibrating mass on top of the anode paste) [1].

From 2000 has new functionalities added to this compactor:

a) Extra static force during vibration by implementation of pneumatic bellows pushing on the cover weight.
b) Vacuum vibration by implementation of a vacuum chamber around the vibrating process.
c) Softer isolators (damping shoes) to reduce the transmitted vibration forces to the building.
d) Increased hydraulic dynamical motor power, with soft start- and stop frequency curve, to increase stability and to vibrate larger anodes.
e) Individual control of the vibration period to equalize the “spring-damper” properties for each anode produced (control algorithm implemented in an executable file which communicates with the PLC system in the plant).

The optimizations have led to a compactor which can be adapted to different paste qualities and produce anodes at a high production rate (anodes/hour) and larger anode size (ton/hour).

2. General Functionality

The vibrocompactor is built up with two vibrating masses which compacts the anode paste [2]. These two masses are named the cover weight and the table as the principle drawing shows in Figure 1.

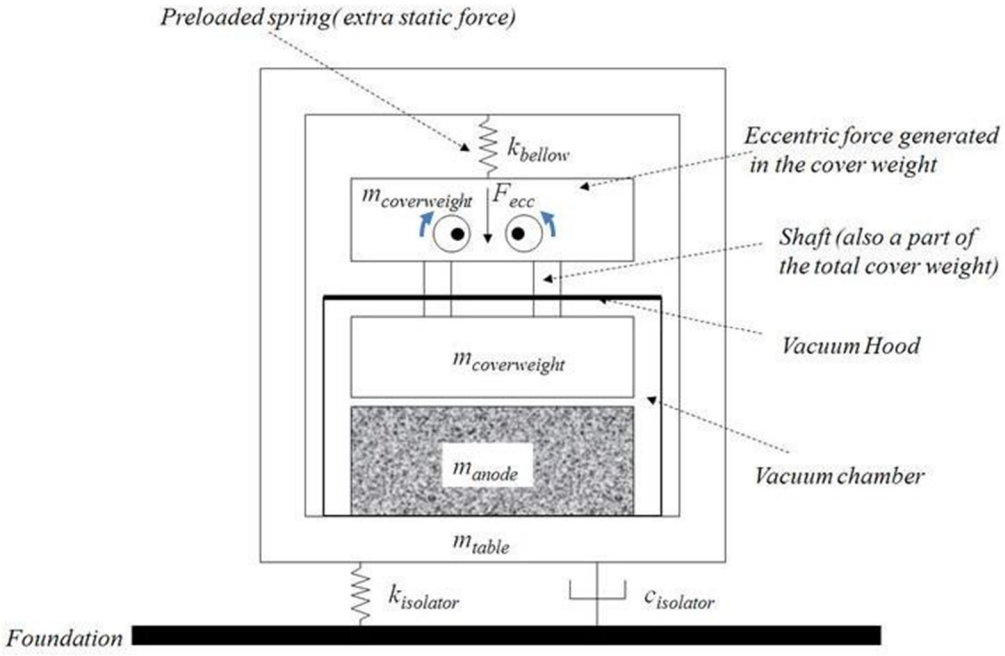

Figure 1. Principle drawing of the vibrocompactor.

The cover weight is the inner active weight since the hydraulic motor, generating the dynamic force, is integrated in this part. The table is an outer passive weight which vibrates due to the movements of the cover weight. The hydraulic motor gives energy to rotate two parallel shafts with unbalanced masses; the one shaft rotating clockwise and the other counter clockwise in order to create the vertical dynamic eccentric input force, F_{ecc}.
The rotational frequency of the shafts is large enough to let the dynamic force overcome the static force in the compactor. The right frequency is reached when the dynamic displacements [mm] do not any longer increase by increased frequency (even if the accelerations increase [m/s^2]). At this frequency, the weight and the table is vibrating at almost opposite phases, around 150°.

When the cover weight, the inner mass, is the active mass the dynamic displacements of it are generally twice the displacement of the table. Another reason for the difference is the weight balance; the cover weight is generally only half of the weight of the table. The displacement of the cover weight will therefore be closer to the table displacement when the mass of the cover weight increases.

The anode paste from the mixing- and homogenization phase can enter the two silos of the compactor in two ways; by one inlet using a paste splitter or by two inlets without the paste splitter. The compactor height could be reduced by dropping the splitter. See Figure 2.

The hoppers of the compactor is not thermally isolated. Experiences showed that the paste had minimum of sticking in the hopper without isolation. In addition, the sticking effect was further reduced by always changing which hopper to be first filled with paste. The maximum time between fillings of a hopper was therefore increased without decreasing the anode capacity.

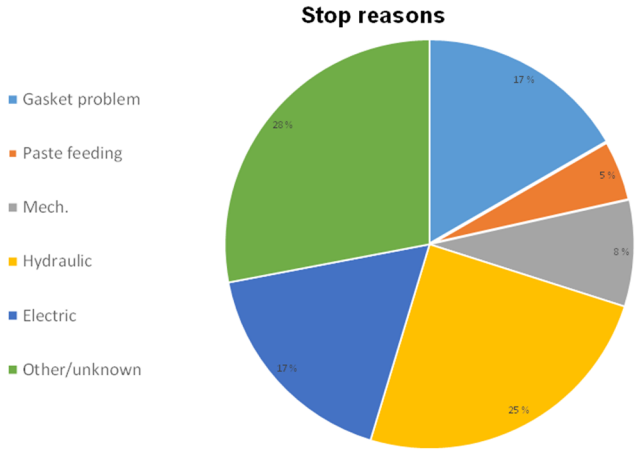

Figure 14. Example of reasons for unplanned stops at a Hydro plant.

8. Conclusions

The HAL vibrocompactor where the cower weight is the active mass, has been developed over the years where new functionality has been added as vacuum forming, extra static force with pneumatic bellows outside the vacuum chamber, modified eccentric forces and isolators to foundation. The dynamic input force comes from robust hydraulic motors which is small enough to follow the vibration (fixed to cover weight vibrations).

Both vibrational FFT measurements during anode compaction and nonlinear transient compactor models have been used as tools in the development of the compactor.

The compactors have run for several years at different Hydro paste plants and have shown to achieve high densities at low compaction times. Less vibration sequences, smaller vacuum chamber to reduce suction time and higher cover weight amplitudes (since this mass is active) makes the single-mould-compactor to achieve high anode capacities in a paste plant line.

9. References

[1] Patent no. NO132359B: Vibratory device for creation of mould bodies for the production of anode and cathode blocks for the melting industry, especially the aluminium electrolysis industry.

[2] Patent no. WO 03/068468 Al: A method and equipment for compacting materials