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TRANSFERRING COMMON HPGR APPLICATION FROM COPPER TO LITHIUM ORE

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Abstract
During the past 45 years, HPGR technology has made continuous progress, while simultaneously drawing on more than 125 years of experience with high-pressure processing of materials between counter rotating rolls for briquetting and compaction.
Following the success stories in the cement industry, HPGR technology became known and caught on in the mining industry as well. Especially the continuous development of wear resistant grinding tools made the economical use of HPGR possible. Typical benefits are energy savings, metallurgical advantages, reduced specific wear costs, production increases and investment savings.
Whereas the physical activation through micro cracking has been in use in the Copper industry from the beginning, the application for Lithium ore has become public only within the last years. As both materials heavily supply for growing industries such as electrical cars and battery productions this contribution will strive to explain experiences in detail along with new developments in the field of HPGR grinding circuits.
Keywords: *HPGR, copper, lithium*

1. INTRODUCTION

Processing of powders in between two rollers is a unique technology applicable for various industries. Figure 1 shows some typical classes of use, with Briquetting and Compaction forming small to coarse particles and comminution forming coarse to fines ones. The HPGR comminution practice is based on the research work of the German Professor Klaus Schönert [for example 2, 3, 4, 11]. Köppern, as one supplier of HPGR's, has worked more than 125 years on roller presses, starting with the formation of coal briquettes between two synchronized rollers. The first HPGR grinding solutions were implemented in the cement industry, where the downstream energy savings provided an advantage for this medium-cost product [5]. Since this success, state of the art mining projects evaluate the application of HPGR technology versus SAG milling [1].

Figure1. Overview of roller pressing applications; left Briquetting, middle Compaction, right Comminution

Transitioning the grinding principles of HPGR to mineral applications however was not straightforward, due to the much higher wear rates caused by the significantly more abrasive materials. However due improvements of the roller surfaces, especially through the use of studded tires, mineral grinding applications ranging from copper and iron ore to hard rock applications are now commonplace [6][8].

Through such innovations, the benefits of HPGRs in mineral processing applications have been successfully proven not only through test work, but also in many industrial applications (for example [9] [10]). The increase of throughput, overall energy savings and reductions of the workload on downstream equipment, such as ball mills, are all well-known advantages of the implementation of HPGRs. The total benefit, however, depends on the minerals being processed and the material activation within the working gap [7]. Fugere 2 shows an open HPGR during assembly for general todays sizes references.

Figure 2. Modern size HPGR in production workshop

2. KNOWN COPPER EFFECT

Various publications are available which prove the results of mechanical activation towards the downstream of HPGR [summery overview in 12].

The activation and grinding between the HPGR gap is enhanced by four main effects [8]:

a) The retention time in the grinding zone is short, about 10 ms,
b) The stress is multiaxial as particles are activated in a bulk,
c) The stress level in the activation zone is very high (≥ 250 MPa).
d) All material has to pass the gap and the volumetric usage of machine is up to 100%.

For materials with a small proportion of elastic components in the feed, the activation results in [8]:

a) A high share of fines in the product and effective grinding,
b) A preferred breakage along the grain boundaries,
c) A low amount of ultrafine particles (< 0.010 mm), small particles can hide in bulk gaps and the amount of attrition is low,
d) A pre-weakening of grain structures due to formation of micro-cracks (example see Figure 3)

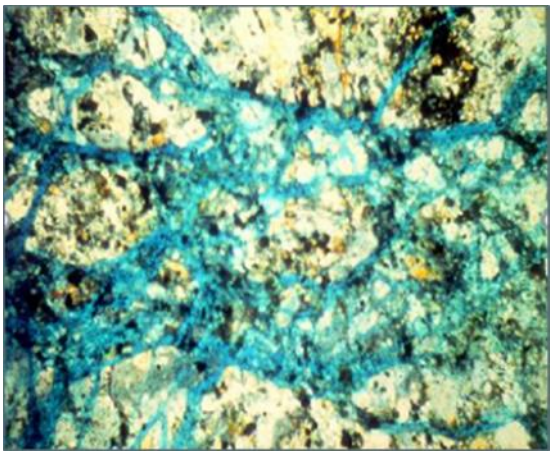

Figure 3.Micro-cracks coloured in a HPGR product [13]

Figure 4 gives an example of the downstream effects of copper leaching results after HPGR according to Baum with typical high speed up potentials [13].

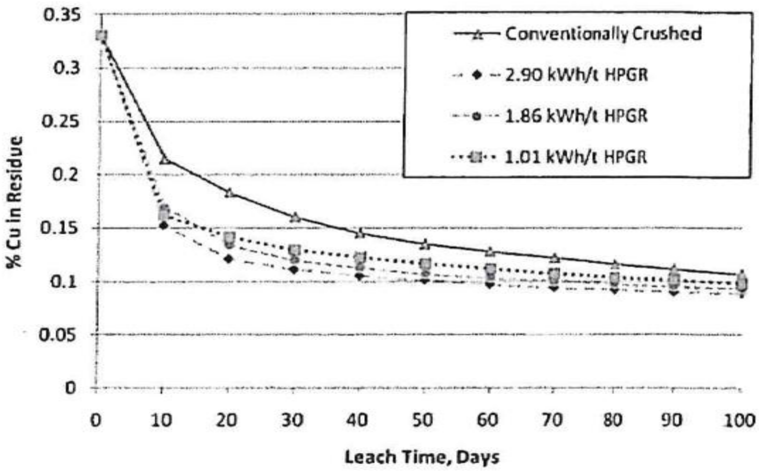

Figure 4. Comparison to leach kinetics between conventional cone crush and HPGR comminution [13]

3. TRANSFER TO LITHIUM

Independent of the above mentioned micro-fractures, HPGR stress paths through the material in the gap show significant effect on various minerals phases. Figure 5 shows one example for iron ores [14].

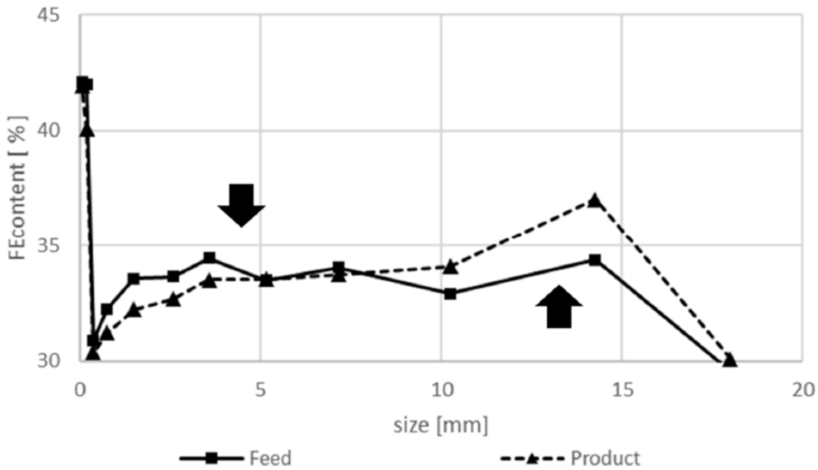

Figure 5. Preferential breakage inside the HPGR [14]

Following the battery boom of the last years and the high demand for Lithium based ores, HPGR machines have also been implemented in Pegmatite process lines. Because of their coarse grained rock structure certain lithium ore deposits are especially suitable for selective comminution of HPGR. Due to the physical principles acting in particle bed comminution and the fundamental laws of fractures mechanics HPGR have shown to increase liberation size and shift valuable Lithium away from ultra fine particle sizes. A secondary result is the increase of silica in the middle size ranges where dense media separation set ups can be used for early sorting.

4. SUMMARY

Selective grinding is a key effect within HPGR processes. The extended abstract refers to various studies assessing this topic and possible solutions in view to optimizing down stream recoveries. Upcoming possibilities for finer cut sizes by using dry air classification systems may be a key driver to boost both the Copper and Lithium industries as well as Battery CAPEX prices.

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