Optimisation Platform for copper ore processing at the Division of Concentrator of KGHM Polska Miedz S.A.

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Abstract. The idea of Optimisation Platform is to create an innovative system. It is dedicated to technology and cost efficiency improvement of process realized at the Division of Concentrators of KGHM Polska Miedz SA. This highly sophisticated tool is based on visual, acoustic and vibrating detection systems. The range of its functionality was described in this work. Three main utility modules were described: froth flotation image processing (FloVis), grinding and classification monitoring (MillVis) and belt conveyors control unit (ConVis). The effects of implementation of the system under KGHM conditions were described. It is concluded that the Optimisation Platform is one of the most promising solution for improvement of technology and economy performance at the Division of Concentrators of KGHM Polska Miedz S.A.

1 Introduction

Nowadays the optimisation systems of process control is one of the most dynamic developing area at the Division of Concentrators of KGHM Polska Miedz S.A. Their importance has grown since acquisition of a great volume of variable data. Managing such a number of parameters is out of control for a human operator of the industrial machinery. An optimisation platform is the answer for the current demand regarding data processing. Implementation of platform utilities was possible thanks to realisation of research and development projects. The first introduced solution was flotation cells control unit based on recording the visual data system called FloVis. The successful in implementation of FloVis determined the direction of new research. As a result, a grinding control system (MillVis) and a belt conveyors control system (ConVis) were developed. Finally, the whole utility was created, based on the advanced knowledge, including data analysis, processing visual, acoustic and vibrating signals as well as process optimisation technology.

2 Structure of Optimisation Platform

The Optimisation Platform has a module structure. Its specific modules with their functionality are presented on Fig. 1.

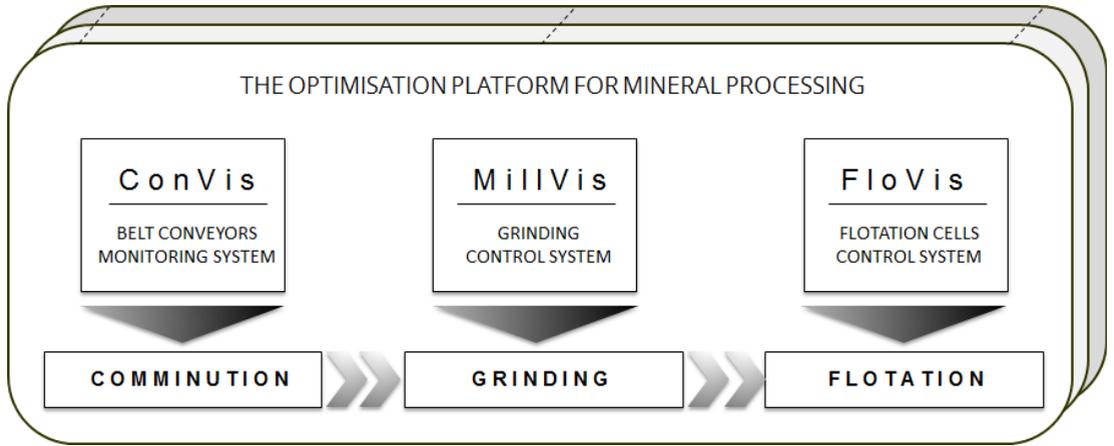
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Figure 1. Modules of Optimisation Platform.

At the first stage of production, the ConVis system will be used. It is dedicated to control working parameters of belt conveyors operating in comminution (crushing) circuits. The physical state of belt and its operating condition is measured by the linear scanning laser and visual camera. The working parameters are: cross-section geometry of the belt, its velocity and load of material. Simultaneously, recording of vision pictures enables estimation of mass and volume flow of the transported material. The important functionality of the ConVis system is detection of abnormal position of the belt caused by potential belt damage. The system is currently under implementation. The economical evaluation of results will be possible after project commissioning.

Grinding and classification processes are supported by a MillVis system based on recording visual, acoustic and vibrating signals. MillVis is acquiring visual pictures of ore material conveying to the first stage of grinding. The system allows for detection of increased number of coarse grains (over 15 mm) and approximated estimation of lithology constitution of rocks [5]. Those parameters influence directly the performance of the comminution process conducted in mills. Even roughly estimated, they are useful for maintaining the optimised throughput. Hence, the information supplied by the system is a base for making decision on operational regime of the grinding sections. The system delivers data on real-in-time state of grinding mill and ground material. After implementation of the system, a broad range of process data is available due to visual pictures and also acoustic and vibrating signals recorded during mill's run. Three application dedicated for input data processing are presented in Table 1.

Table 1. MillVis system applications [3].

Application	Measured parameter	Task
Vision	Visible picture of mill's feed	Assessment of variability of mill's feed granulation and lithology composition
Vibration	Analysis of vibrating signal of mill's shell	Diagnostic of mechanical state of liners and lifters
Acoustic	Analysis of acoustic signal in mills space	Assessment of mill's effectiveness due to grinding media load and rotation speed

The MillVis system is responsible for optimising the grain size of the feed in grinding and classification circuits while being prepared for flotation process. Thanks to MillVis implementation, the grinding and classification bottleneck can be eliminated. The MillVis system influences positively the electric energy effectiveness, creating 1.3 million PLN annual cost decrease. MillVis allows for either reduction of a number of running mills or their more effective use.

The major system dedicated to the control the flotation process is the visual system for optimisation of the flotation cells operation (FloVis). Pictures of flotation froth are digitally processed after being recorded by cameras placed above the surface of the flotation cells. The stages of images processing are presented in Fig. 2.
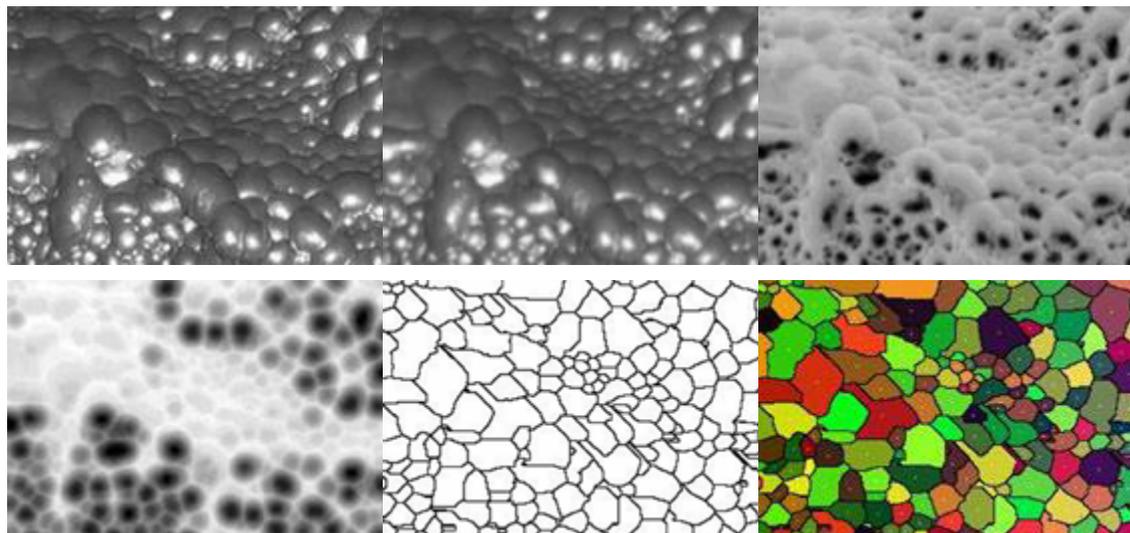

Figure 2. Stages of foam image processing [2]**.**

The developed image processing algorithms determine the values of visual parameters, characteristic for actual froth quality. Visual parameters include the froth structure, bubbles variability, their velocity, froth transparency and RGB colour components of the froth. The flotation process operational parameters are monitored and corrected on the basis of froth visual parameters [1]. Implementation of this system has a great importance due to a crucial role of flotation as "the heart" of the ore processing technology developed at KGHM. Moreover, the optimised operating regimes of flotation circuits influence positively technology effectiveness and cost reducing [2].

FloVis is a master visual control system equipped with an important functionality of flotation process optimisation. The FloVis application results in better process stability. Moreover, it positively influences the main process operational indexes [5] leading to:
- decreasing Cu content as mass% in final tailings by 0.038%,
- increasing concentrate Cu grade by 1.34%,
- decreasing of concentrate yield circulated in cleaning circuits by 12%,
- increasing operational copper recovery in flotation cells by at least 0.7%.

The already designed and employed application modules of Optimisation Platform are dedicated to local monitoring and control of production sections. The development of fully sophisticated platform assumes a strict connection between the FloVis system, measured parameters of coarse comminution (ConVis) and grinding (MillVis) as well as maximisation of metal recovery from the ore as a result. Such a solution as the Optimisation Platform is an example of synergy, where cooperation and communication between several modules give a better technical and economy result than summarized results of each of them working separately.

It needs to be added that currently the Optimisation Platform does not include the last production step realized at KGHM, that is dewatering of the copper concentrate. However, a feasibility study of this project has been launched. The component, being designed, is named DryVis being a system of monitoring thermal dewatering process, including the control of fuel (natural gas) consumption.

3 Summary

The Optimisation Platform is a global, breakthrough solution being implemented in the ore processing industry. It is a sophisticated, fully automatic, still developing tool for changing conditions of working at the Division of Concentrators of KGHM. Thanks to its implementation, a reliable and modern system of control and production optimisation is available. It ensures support for production engineers and operators in the 24/7 access regime. The Optimisation Platform forms a perfect tool to a further development of production processes. It improves decision making processes, eliminates errors and helps to maximize economy benefits. The Optimisation Platform is a base of Intelligent Production Chain. It provides security, technology effectiveness as well as possibility of successful and flexible production process management from ore delivery (ConVis), its preparation for flotation process (MillVis), and finally copper concentrate production (FloVis). In the ore processing industry, the innovativeness and usefulness of such solutions were used for creation similar products by global research centres. However, their functionality is much smaller than the Optimisation Platform.

References

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