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The innovative method of testing solid fuels as an answer to safe and sustainable supply of raw materials –the example of coking coal parameters

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Abstract: The metallurgical coal (coking coal) has been defined as the critical raw material (CRM) in the European Union. Using that type of coal in the coking plants allows it to produce high quality steel and steel products in steel mill around the world. Coking the metallurgical coal is a really complex and demanding process. The formation of coke with high strength and appropriate reactivity depends on the composition and coking properties of the mixture. Coke reactivity testing is recognized as the primary measure of coke quality. The most important and reliable indicators are CRI (coke reactivity index) and CSR (coke strength after reactivity). The most expected values are low CRI and high CSR results. To choose a correct and safe mixture of metallurgical coals to coking procedure, an adequate tests need to be done. The CLP-B Laboratory invented and implemented a new tool that allows to calculate the possibility of adverse reaction occurrence in coking chamber based on CRI/CSR and other coals parameters.

Keywords: critical raw materials, metallurgical coal, coke, CRI/CSR, risk calculation

1. Introduction

The sustainability supply of raw materials – like metallurgical coal – requires balanced, cost effective and environmental friendly mining, to provide the best quality type of coal. Coke – the intermediate product is a fuel in the coking chamber when the final product – the coke is produced. The economic growth is linked with high crude steel and steel products demand, which is also connected with higher coke production. The world coke production has been constantly increasing with stabilised period after 2015 – when 700 mln t of coke is being produced every year (Fig. 1). Housing, construction and road engineering have to be supplied by good quality steel. Since 2000, global crude steel production has doubled and the forthcoming years should be closed with production over 1800 mln t (Fig. 2). In Polish coal mining area, the metallurgical coal, as critical raw material, is hard to extract due to difficult geological and mining conditions (*Annual Report, 1993-2021; Kędzior, Dreger 2022*). There are mined few types of coking coals in Poland, that's why laboratory tests of metallurgical coals need to be done to provide correct and safe mixture of coals placed in the blast furnace. The produced desired coke quality depends on two main variables: coal blend composition and process condition of the coke oven. Modern blast furnaces demand a high coke quality, an exceptionally high coke strength after reaction (CSR), and a moderate coke reactivity index (CRI) (*Kumar et al. 2021*).

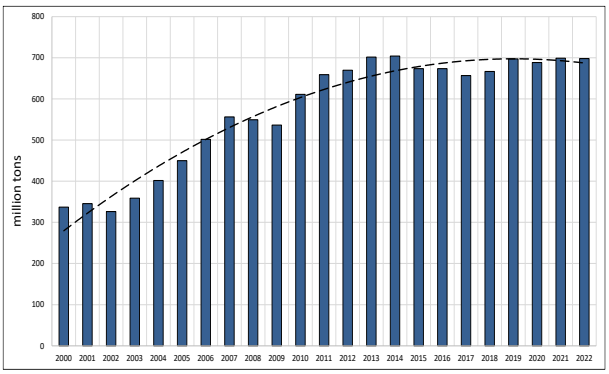

Fig. 1 The world coke production
(after: GK JSW 2020 integrated report – modified)

2. Method

Technological processes according to which coke production takes place require constant control at every stage of their process mileage, which is an important requirement for maintaining the expected product parameters, efficiency and correctness technology and ensuring the profitability and safety of the installation**.** To characterise the coal mix that is put into blast furnace, the pre-tests have to be done in the certified laboratory. Moisture, ash and sulphur content, volatile matter, CRI (coke reactivity index) and CSR (coke strength after reactivity) were taken into new calculation model invented in the CLP-B Laboratory, which numerically describes the danger of coking process.

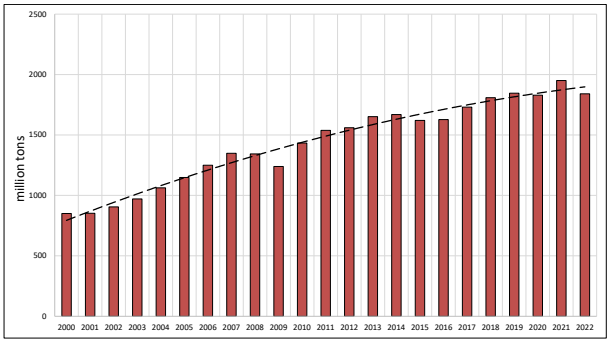

Fig. 2 The world crude steel production
(after: GK JSW 2020 integrated report – modified)

3. Results

The result of the conducted research is the identification and development of key elements of the procedures measurement methods, constituting the basis for developing a methodology for measuring the change in the volume of the material subjected to the process coking, the innovation of which is manifested primarily in the form of repeatable and reproducible results research and the possibility of translating them into the needs of controlling industrial processes in coking plants. The development of new tool allows coking plants to safe and sustainable management of the critical raw material – coking coal (*EU COM 2020 (663) final*).

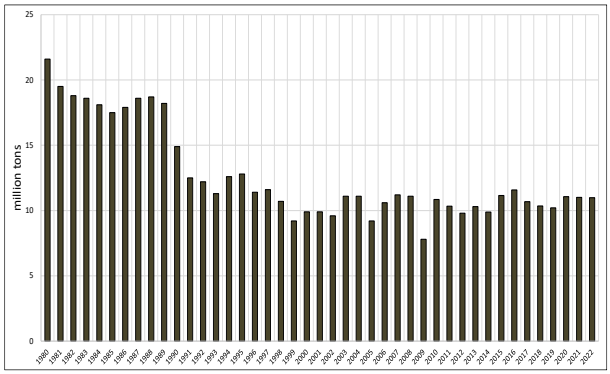

Fig. 3 The coking coal production in Poland
(after e.g.: Annual Report, 1993-2021– modified)

4. Conclusions

The hard coal mining in Poland operates mainly on the basis of domestic raw material to a small extent supplemented by imports. The coking coal production in Poland oscillates around 10 – 11 million. tonnes (Fig. 3) (*Annual Report, 1993-2021; GK JSW 2020 integrated report*). About 85% of the extracted raw material is utilized by the coking industry producing coke for the steel industry, the remaining 15% is exported. The steel manufacturing requires the highest quality of coke which can be assured by certified laboratory tests (measuring metallurgical coal parameters), like the new calculation model invented in the CLP-B Laboratory, which numerically describes the danger of coking process. The safe and sustainable management of the critical raw material is a challenge faced by large corporations. The certified laboratories use the modern technology to provide the best possible solutions.

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