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The basic principles of iron making will be introduced throughout the historical development chronology. The final result of this presentation should be a basic understanding of the iron making process and the roots of the modern blast furnace facilities and operation. A blast furnace involves significant capital and energy intensive processes. Due to complex phenomena and the difficulty of taking measurements, the knowledge needed for process optimization can be most readily obtained through the development of high fidelity computational fluid dynamics CFD modeling and simulations. Such modeling and simulations are powerful tools that can provide detailed information on hydrodynamics, heat transfer, and chemical kinetics for gaining fundamental insights, investigating the impact of key operation and design parameters, and developing strategies to optimize the blast. Recently, Virtual Reality VR technology has provided an efficient means of visualizing and analyzing huge amounts of CFD data in a virtual environment. The Blast Furnace Simulators have been used for the troubleshooting and optimization of blast furnace operation, resulting in the saving of multiple millions of dollars and significant reduction of furnace downtime. The Virtual Blast Furnaces have been used for training in steel companies and have received excellent feedback. This is only to be expected since a number of quite different raw materials are used and the furnace environment spans a very wide temperature range. A good grasp for a small number of these reactions is essential to any reasonable understanding of the process. These key reactions involve iron oxides, carbon and carbonaceous gases. Our time today will be spent mainly on these. However, some references will also be made to elements that present problems â€" either to the blast furnace process itself or to its steelmaking customers. The physical configuration within the furnace needs to be understood since the important reactions occur between gases and solids and the efficiency and continuity of these contacts must be assured for good operation. The physical structure of the Cohesive Zone and its role as a gas distributor will be examined. Topics such as raw material quality, burden distribution and tuyere practice are also of vital importance in the control of the chemical reactions upon which stable and efficient operations rely. These will be covered in detail in other lectures of this course. That opinion is wrong. It turns out that standardized approaches to the more challenging operation circumstances are both available and proven to be directly applicable. This paper will be specifically address some general rules to avoid getting into blast furnace difficulty in the first place, followed by more detailed explanation of four elements of furnace shutdown bank, gravel bank for reline, salamander tap, and blowdown , two types of restart from bank and from empty furnace condition , and an additional segment on recovery from a cold furnace or chilled hearth condition. In each case, fundamental principles, and their application, will be explained. One of the fundamental principles applied to Blast Furnace safety is Hazard Awareness. In this paper and presentation will discuss what a hazard is and how to evaluate the risk of each hazard. The responsibilities of the employer, supervisor and worker regarding hazards defined in legislation will be reviewed. The different types of hazards associated specifically with blast furnaces will be outlined along with the different methods of controlling hazards in the workplace. The manner of charging raw materials to the blast furnace affects the distribution of gases that reduce and heat the descending burden materials. The distribution of burden and gases in the stack has a strong effect on the efficiency of gas-solid reactions and on shaft permeability. These in turn have a large influence on furnace performance as measured by fuel rate and productivity. In addition, burden and gas distribution have an effect on furnace lining life and hot metal chemistry. In this lecture the effects of raw material characteristics, charging practices, charging equipment and furnace geometry on burden and gas distribution and furnace performance are presented. Fundamental concepts and techniques used to physically and mathematically model burden and gas distribution are reviewed. Practical applications of instrumentation to measure and control burden distribution are presented. Some examples are given concerning the use of various types of charging equipment to improve burden and gas distribution and furnace performance. Finally, some principles are outlined for the optimization of burden and gas distribution with respect to furnace fuel efficiency, productivity and lining wear. A summary of useful blast furnace related data from numerous sources is presented. Tuyere zone, stack and general blast furnace reactions are reviewed from an energy standpoint. The impact of variability in blast furnace input parameters is discussed. These principles are demonstrated through a computer simulation model "The Blast furnace Game" that uses mass, energy, chemical and cost balances to assess means of improving the blast furnace process. Understanding the needs of each department will ensure an optimized solution. The production planning process translates market demands into facility deliverables for each operation. Hot metal specifications generally reflect a balance between the plant infrastructure and technology utilized, process capability, raw material inputs along with the internal customer requirements. Management of hot metal inventory is a primary consideration for operational and process control which supports the monthly or annual production and cost targets. Opportunities to lower costs are available through recycling of by-products and other wastes into the Blast Furnace. This lecture which is complementary to others being presented on the course, reviews the following components and sub-systems which form the blast furnace iron making plant. Discussions on combustion reactions and raceway phenomena will provide the background to the concept of replacement ratio. Examples of the replacement ratio will be given. The impact of fuel injection on burden and gas distribution will be described. The injectants discussed will be natural gas, oil, tar and coal. The desire to improve blast furnace operation and lower operating costs have led to significant increases in hot blast pressure and temperature during the past forty years. These changes have required considerable design and operating improvements to be made in the air and gas system designs. The subject will be covered in the following areas: The presentation will follow a path beginning with a review of technological limitations on pre designed casthouses and refractories. The discussion will follow the evolution of this modernization including installation of tilting runners and a fugitive emission collection system during operation, results of trough water modeling studies, and the complete revamp of both casthouses during a reline. When a Blast Furnace reaches its end of campaign must be performed a campaign extension plan or a reline outage. In the last years Blast Furnace Campaign Extension and Reline have become very important for Ironmaking under its four key issues: This lecture will present the different aspects of each stages of a Blast Furnace Campaign Extension and Reline as: Peter Schmoele, ThyssenKrupp Steel Europe AG, Germany This presentation will focus on the evolution of iron making practice in Western Europe in the past and highlight some technological aspects, like: Introduction into the development in hot metal production, progress of the structure of reductants and ore burden materials, evaluation of constructional features and equipment of the blast furnaces, presentation of the largest European hot metal producing companies and further outlook for the European ironmaking scenario. The integrated steel works in EU 27 operate many modern plants for the production of a wide variety of high grade steel products. Control of emissions is mainly related to concentration of dust, SO2, NOx, dioxins and other substances. Some developments in sinter plant waste gas cleaning or waste gas recycling are presented. One main focus is set on the emissions of CO2 and the CO2 emission trading system. New processes in ironmaking to reduce CO2 emissions are described. The plunge in order intakes in late called for decisions which produce immediate effect, in order to adapt the entire chain to the requirements, beginning with logistics and warehousing of raw materials down to the linked production units of integrated works. Suitable measures realized at coke oven batteries and blast furnaces are described. Results are based on basic hot metal only and do not consider foundry iron 8. The blast furnace is one of the most efficient iron making facility in existence. The iron making process must have reliable refractory systems to sustain its operation. All high temperature process areas are protected by refractory systems. This paper focuses on refractories systems and materials with which operators have to cope with. Also equipment components, which depend on long-term stability of the refractory systems, like the furnace hearth and hot blast stoves, are reviewed. The criteria in taking the proper steps for iron making refractory materials selection and how to operate systems with-in predictable limits will be discussed. Zhou Center for Innovation through Visualization and Simulation Purdue University Calumet A blast furnace involves significant capital and energy intensive processes. This lecture will cover how properties of pellets and sinter affect blast furnace performance in terms of fuel consumption, production, and campaign life. The choice between pellets and sinter is largely a matter of mineralogy of ore and geographic location of iron ore sources relative to the steel mill. Limestone and dolomite fluxed pellets are widely used in North America in view of their improved metallurgical properties which significantly improve blast furnace efficiency. Recycling of in-plant generated steel mill wastes has become an important function of the Sintering process. Briquetting is occasionally employed for the same purpose. Handling, economic, and technical considerations in using these unconventional materials in the blast furnace will be covered. An integrated system perspective, including iron production priorities, blast furnace equipment, and raw materials, is essential for selecting optimum iron-bearing burden material composition for a specific blast furnace. Following the footsteps of European and Japanese iron makers, the Chinese has pushed the science and art of ironmaking to a new level garnered by vast numbers of trained professionals in ironmaking and steelmaking, supported by many universities and research institutes, and guided by various government agencies. The presentation covers the widely practiced top gas dry dedusting system, highly efficient top fired stoves and many new and innovative wastereduction and energy-saving technologies such as waste heat recovery and zero blast furnace gas flaring at many blast furnaces in China. The largest blast furnace 5, m3 in the world built at Shagang is briefly described. Future challenges for the Chinese blast furnaces and practices are also presented. All need to be achieved consistently at an acceptable cost. The development of sound operating control strategies is a basic necessity. Near term control of production rate and quality are strongly dependent on strategies to control thermal balance and gas distribution. These are increasingly based on complex models founded in basics of thermodynamics and fluid flow. Data from sophisticated sensors and probes is required for successful application. Proper calibration and maintenance standards are essential to operator confidence and interpretation. In the longer term, decisions about raw materials sourcing and preparation set the foundations for process capability. Decision makers must be able to respond to variations in market pricing while respecting guidelines that define the boundaries for adequate operation. In both the shortest and longest terms, diligent monitoring of asset status provides the key to maximising process safety and value extraction from any furnace asset. These data also provide the best basis for improvement decisions at reline time. This paper will also discuss hearth dynamics and explain the formation, behaviour and influence of the deadman coke bed. The interpretation of hearth thermocouple data in relation to both refractory wear and liquid flow regimes will also be discussed. The last decade was a turbulent for the steel industry. The reorganization of steel industry across borders has progressed and the increased demand for steel products has made the price of raw materials such as iron ore and metallurgical coal more volatile than ever. Ironmaking technology division in JAPAN has been exposed to global competition and has tried to cope with these changes and to increase its international competitiveness by developing such technologies as utilization of lower grade raw materials, productivity enhancement, measures for energy conservation and reduction of CO_2 and NOx emission and so on.

Chapter 2 : principles of blast furnace ironmaking by AK BISWAS

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A blast furnace is a type of metallurgical furnace used for smelting to produce industrial metals, generally iron, but also others such as lead or copper In a blast furnace, fuel, ore, and flux (limestone) are continuously supplied through the top of the furnace, while a hot blast of air (sometimes with oxygen enrichment) is blown.

Chapter 7 : Ironmaking,Blast Furnace,China Steelmaking,Steel Business Provider

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