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Steel vacuum degassing.

In this example, we see how the process metallurgy module can be used to simulate the vod process. The example is configured to reproduce the VOD process described in the publication by Ding et al. [R. DING, B. Blanpain, P.T. Jones, P. Wollants, Met. Mater. Trans 31b (2000) 197-206]. The cynical simulation reproduces the temperature, the chemical of steel and the chemistry of the scum as time function. The example can be easily modified and adapted for different pharmacies and process parameters. Evolution of the simulated temperature during the VOD process, carried out with the process metallurgy module in thermo-calc. November 14, 2017 by Vacec Aero International during the steel manufacturing process, while molten steel is still in the teaspoon and before the steel must be worn out to: (1) Reduce/remove dissolved gases, especially hydrogen and nitrogen; (2) reduce dissolved carbon (to improve ductility); and (3) Promote the preferential oxidation of dissolved carbon (on stainless steel). In the steel melting process, unwanted gases dissolve in the liquid, which could produce a number of imperfections and defects. A main aim is to eliminate these unwanted gases in empty wear. The process is carried out after the molten steel has left the oven and before being poured into ingots or introduced into a continuous melting (Fig. 1). GRANFIC 1 MMAN OF CONTINUOUS STEEL FUNDITION3 VACUUM DEGASING SOLVES A critical problem along the initial part of the 1900, the sidermic industry was plagued with poor quality steel this was due to the fact that during the process of Production, the hydro-gene gases and nitrogen were present in molten steel. During cooling and subsequent solidification, dissolved hydrogen caused holes and in the final product, since hydrogen has low solubility in steel at room temperature. The result was the release of during solidification, even the presence of some parts per million hydrogen gas causes defects and loss of performance strength. Nitrogen also has low solubility in steel, less than 10 ppm at room temperature. As steel cools and solidifies, nitrogen is rejected again resulting in defects in the final product such as the embryo and reduced ductility. The solution was to pull a vacuum on the surface of the cast steel while heated, that is, to perform a vacuum degasification operation. The idea of hearing a vacuum to eliminate dissolved gases from cast steel was initially proposed in 1940 by Soviet scientists a. m. samarin and L.M. novik. was tested indotrially in 1952 at the enakievskii metallurgical plant in the Soviet union and in 1954 in German. By 1960, the most efficient vacuum degasification methods, such as dortmund hoerder (dh) and Ruhrstahl-Heraeus (rh) methods, became popular. were followed in the mid-1960s by additional processes such as vacuum arch wear, ASEA-SKF process and vacuum oxygen decarbonation process for high chromium steels. shortly thereafter, this technology became an essential part of the steel manufacturing process and is now used worldwide. The efficiency of vacuum wear in the elimination of hydrogen and nitrogen from steel is due to reduced pressure between cast steel and vacuum, which makes gases less soluble and separated from liquefied steel. In the case of oxygen removal, the process is similar and is called deoxidation, which is a chemical reaction between carbon and oxygen. carbon is combined with oxygen, resulting in a carbon monoxide (c + or = co.) this carbon monoxide gas is rejected from the steel surface in the same way as hydrogen and nitrogen. fromdeoxide, eliminates oxygen and carbon culls To better understand this phenomenon, it is a ostil comparing it with how water boils when it is placed under an emptiness. Bubbles form and float to the surface of the water, where they escape. In the same way, the bubbles of hydrógen, nitrógen and carbon monóide in the low empty steel, rise to the surface and are eliminated by the empty system. This technology allowed an economical way to make low carbon steel commercially from the end of the 60.1 at the beginning of the 1980 Ultra-low with a carbon content of less than 30 ppm, so as interstitial free steels with carbon and nitrogen content of 30 ppm or less. In addition, deoxide by empty wear can provide low carbon steel with very low oxygen content. The resulting product has high ductility and is very homogenic. In addition to its metal contribution, the emptying process improves the economy of high quality steel production allowing a less expensive melting process through a comprehensive meter cycle, so as a reduced consumption of alloy and deoxidant additives. The empty wear is a phenomenon of lay layer that occurs in the interface between molten steel and the reduced pressure environment. Effective empty wear depends on the sufficient surface exposed on molten steel. Empty's degasification systems use different ones to maximize this surface. Two mǎ © are discussed all of the emptying of the emptiness: muddy of the candle and wear of the current. Ladle Degassing During steel manufacturing, molten steel is poured from the foundry oven to a container called spoons (Fig. 2). In the world's mismanagement of the teaspoon (also tank), the teaspoon is placed in oăcav oăcav omoc allirăcuc atos al azilătu ovitanreġla oē:Ăesid nU jgh mm 0.01 à mm 5.0f rabm 0.31 à 7.0 ed oăcav nu acilpa es y adalles (Ăse aram:Ăe al oăcav ed aram:Ăe In this design, the lid is designed with a vacuum-adjusted seal between itself and the grid. To ensure that the necessary surface of cast steel is exposed to vacuum, steel is revolved to keep the new steel from constantly taking to the surface. This makes blowing an inert gas like argon through cast steel (Fig. 3). The argon is introduced through the bottom of the cradle through a porous refractory plug. Additional agitation is generated by the deoxidation reaction, since carbon and oxygen are combined to form gaseous carbon monoxide, which forms bubbles that rise through cast steel and promote the mixture. There is a hopper with a vacuum lock on the roof of the cradle, known as an additional hopper. It allows the addition of alloy elements during the degasification process. The desulfurization slag, commonly a mixture of CaO, MgO, MnO and FeO, is also introduced through the hopper to remove any unwanted sulfur from the steel while it is under vacuum. Figure 2 – Cast steel transported in a teeming ladle2 Figure 3 – Ladle (tank) degassing arrangement4 Stream Degassing Stream degassing involves drawing a vacuum in cast steel while it is poured from a feeding tank (referred as a tundish) to the casting mould. During the spill, steel breaks into drops that greatly increases its surface. Since wear depends so much on the exposed surface, wear occurs very quickly (Fig. 4) when steel falls into the mold. The height of cast steel drops (i.e., the height of discharge) is one of the most important variables that impact the effectiveness of the process of degasification of the current. In addition to the degasification of the candles to the legs, there is another variation that is known as the ladle-to ladle-degassing, in which is a second spoonthe vacuum chamber, instead of the mold. Due to the rapid degasification nature of the current, this method is used to view ingots as large as 400 metric metric metrics (880,000 (880,000 lb.) or larger, requiring multiple ladle pours. Figure 4 | Stream degassing4 Vacuum Pump Selection In order to select the best pump for vacuum gassing, several variables must be considered. The time available to draw the vacuum on the chamber, based on the production rate and other factors. A higher production rate requires a faster drawdown and higher capacity pump. The volume of dissolved gases to be removed from the steel. A higher degassing rate will require a more powerful pump system to maintain vacuum while pumping the liberated gases. Argon flow, in the case of ladle degassing. The vacuum pump has to remove not only the liberated gases but also the argon being used to stir the molten steel. The vacuum level required to provide satisfactory outgassing. This is affected by the steel chemistry and the gases being removed. The leakage rate of air into the vacuum chamber. Any air leaking into the system needs to be removed by the pump. The price of steam and electricity. There are three types of pump systems used in vacuum degassing: (a) steam ejectors with necessary condensation stages; (b) steam ejectors in combination with water ring pumps; and (c) dry screw pumps, which doneĂĂt require a steam ejector. Steam Ejectors Steam jet ejectors use the venturi principle to create a vacuum by forcing steam through a nozzle. The nozzle provides controlled expansion of the steam, which effectively converts pressure into velocity, producing a vacuum. This draws in and entrains any gases present which enter at the bottom (Fig. 5). The steam is mixed with the pumped gases and passes out of the ejector. Steam ejectors are commonly used in multiple stages for vacuum degassing by piping them in series, sometimes with condensing sections between them. While a single stage ejector can provide a 40 mbar vacuum, multiple stage ejectors can attain an ultimate pressure of 4 x 10-3Ă mbar. Steam ejectors have the advantage of Mixed pieces and, consequently, high reliability and low maintenance. An important criterion when considering steam ejectors is the availability and cost of steam. Figure 5 | Steam ejectors use the steam since the gas water ring pumps6 of motive6 Several ejectors in series, followed by the Líquido Ring pump. The flake pump is considered a host -style pump of positive displacement. Figure 6 | Empty system using a two-stage vapor ejector with a líquido 5 -style bomb pump, the hill -style pump is based on a hair to provide the seal between rotating palettes and the housing of the bomb. In empty masking applications, the pump is preceded by steam ejectors, which inject steam into the system. This

steam is condensed in the condensation stage that produces a lyh, which is used as a pump seal. The hair of the flaxon is called asã due to the shape of the ring that takes the water due to the centrin strength (Fig. 7). The liquido ring results in a series of stamps in the space between the impairment palettes, which form compression. The eccentricity between the axis of rotation of the driver and the pump housing results in a variation in the volume enclosed by the palettes and the ring. The result is that the gas is compressed and then discharged from a port at the end of the housing. These pumps can produce pressures of up to 30 mbar with lower pressures possible with librides other than water. This type of pump has a pumping speed range of 25,000 to 30,000 cystic meters per hour. Figure 7 | Section of a pump of the 6 Dry screw pumps Another pump system commonly used to wear out the empty is the dry screw pump. The screw pump is a positive and dry style displacement pump. As a dry bomb, it does not require the introduction of a lump in the system and, therefore, is not preceded by steam steam The dry screw pump (Fig. 8) uses two rotary screws, one left hand and one right hand, which mesh without touching. The screws are mechanized to a narrow tolerance and the space between them is very small. This narrow tolerance, in combination with the motion of the rotating screw, prevents the gas leak in the screws by creating a seal. The rotation of the screws transfers the gas from one end of the pump to the other. The screws are designed to reduce the space between them as the gas passes along, and is compressed, causing a reduced pressure at the pump's inlet. This pump has high performance capacity, good liquid handling and tolerates dust and hard environments. Typically, a maximum pressure of 1 x 10-3 mbar can be reached. The screw pumps have a pump speed range of 50 to 539 cubic meters per hour. Figure 8 – Cutting view of a dry screw pump7 Summary Vacuum wear plays a critical role in steel manufacturing. The vacuum degasification process allows the production of high-quality, low-carbon and ultra-low carbon steels and stainless steels, with minimal oxygen, hydrogen and nitrogen contamination. The main benefits are: Reducing the hydrogen content to prevent the intoxication of steel. Reduction of oxygen content to improve microcleanity. Improve the distribution of alloy elements and other additives. Control the steel composition to the most adjusted chemical specifications. Improve mechanical properties such as uniform transverse ductility, fatigue resistance and high temperature performance. Reach exceptionally low carbon steel heats beyond those that can be obtained by conventional means. References Ispat Guru (www.ispatguru.com) NIPic (www.nipic.com) New Mining and Energy moc.muucavsdrawde.www(moc.muucavsdrawde.www(muucaV sdrawdE)moc.llorc.www(sdonnyeR llorC)moc.hsandg.www(hsaN rendraG)moc.hcetsbus.www(ygolonhceT & secnatsbuS à hcetsbuS gnissagedmuucav# oreacav# secanrufmuucav#

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