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CATALYST ROASTING PLANT

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The present invention relates to an improved method and apparatus for preparing catalysts, and more particularly to the roasting of catalysts suitable for the production of hydrogen by reaction of hydrocarbons and steam at high temperatures. Such catalysts may be manufactured by first preparing a paste of metals, oxides and heat decomposable compounds of the materials desirably in the finished catalyst. This paste is dried, broken into lumps and heated to suitable temperatures with removal of the vaporized products of heat decomposition. My invention relates to an improved method for conducting this final heating or roasting step.

Referring to the drawings, Figure 1 and Figure 2 are diagrammatic sectional views in plan and elevation, respectively, of an apparatus constructed according to my invention. Figure 3 shows a system of connections that may be used at the top of the catalyst roasting tubes. The following description of the drawings, with an approved method of operation of my apparatus, is given merely as an example of one application of my invention and it is understood that my invention is not to be limited thereto.

Any suitable fuel air is introduced through burners 1 into combustion chambers 2, and is completely burned therein. The gaseous products of combustion pass through ports 3 into a chamber 4 and around tubes 5 suspended therein. Gases are withdrawn from near the top of chamber 4 through ports 6 and flues 7 to stack 8 and are then released to the atmosphere.

Tubes 5 are constructed of suitable alloys to resist the corrosive action of the products of decomposition of the catalyst and of the flue gases at the high temperature to which they are subjected in chamber 4. These tubes have perforated plates 9 supported by lugs 9' in the bottom of each tube. The plates 9 may be easily disengaged from the lugs 9' and removed from the tubes even when the latter are filled with catalyst. The tubes, previously filled with lumps of green catalytic material 10 to a depth about equal to the depth of insertion of the tubes within the heating chamber 4, project through holes in the top of the heating chamber and are supported therein by circular collars 11, upon which the flanges 12 rest. These flanges are connected to the top of the tube and have suitable eyes 13, through which hooks suspended from a travelling hoist 14 may be attached. The hoist moves on an overhead rail 15 and is used in inserting tubes into the furnace, withdrawing them therefrom and in conveying them between the furnace and suitable cooling, dumping and refilling racks (not shown).

The top of each tube contains special fittings for the admission of either steam or air for purposes to be described below. A pipe 16 extending through the flanged head of the tube is connected to a three-way cock 17. To the latter is attached a suitable air hose connection 18 and a pipe 19 and union 20 for connection to pipe 21 which conducts steam from the steam manifold along the top of the furnace. This manifold contains an individual distributing orifice 22 and by-pass 23 for each tube, both of which are connected to main steam header 24.

Means for the final preparation of hydrogen production catalysts of the type described herein have been described in the co-pending application No. 535,306, filed May 5, 1931 by Hanks and Freyermuth Pat. No. 1,943,821 issued Jan. 16, 1934. In that application the final roasting of the catalyst was described as consisting in charging the 'green' catalyst into tubes similar to those described herein. The tubes were placed in a relatively cool furnace, which was then heated slowly to the desired roasting temperature, meanwhile passing flushing gases, such as steam or hydrogen, through the catalyst to remove the vaporized products of decomposition. Catalysts of great physical strength, with a marked resistance towards dusting or cracking into fines, are prepared by this method.

I have now found that roasting large amounts of catalysts for use on an industrial scale, requiring the alternate heating and cooling of a roasting furnace when operated in the above described manner, requires an unnecessary loss of time for the heating and cooling of said furnace and that the alternate expansion and contraction of the latter causes rapid deterioration of the refractory lining. It is desirable, therefore, to maintain the roasting furnace at a constant temperature but I have found that if the said "green" catalysts are subjected suddenly to a greatly increased temperature as by being injected into a highly heated furnace, the value of the roasted catalyst is greatly impaired. For example, gaseous decomposition products are liberated so violently that the catalyst is either broken into small fragments or dust, or is weakened so that its tendency to form dust and fines during subsequent handling or use is greatly increased.

In the operation of my invention I first charge the green catalyst into relatively cold alloy tubes of the class described at some point outside the roasting furnace. The latter is fired to maintain
a constant temperature of about 1600° F. to 1800° F. in the roasting chamber, but other temperatures may be used depending on the nature of the catalyst being roasted. The tube, with the top closed by a suitable flange and an air hose connected thereto, is then lifted by the travelling hoist and carried to a point directly above one of the holes in the top of the furnace. Air is then admitted to the tube by the air hose and a strong current of air is forced down over the catalyst and out through the perforated plate at the bottom of the tube. The tube is then lowered slowly into the furnace while maintaining a continuous flow of air therethrough. By this means the rate of rise of the temperature of the green catalyst is greatly decreased and the desired physical strength in the finished catalyst is secured. After the tube is lowered into place the steam inlet line is connected to the steam manifold on top of the furnace. Steam is then substituted for air, and is admitted at a high rate through the by-pass around the steam distributing orifice. When the temperature of the catalyst approaches within 300 or 400° F. of that of the roasting chamber, or is above at least about 700° F. throughout the main body of the catalyst, the steam supply is caused to pass through the distributing orifice and is maintained substantially constant at any desired rate thereafter to the end of the roast. I have found 30 to 40 volumes of steam per volume of catalyst per hour a satisfactory rate, although wide variation in this rate may be used without substantial effect on the finished catalyst.

The tube is held in the roasting chamber for an extended period of usually about 8 to 72 hours or longer, and is then withdrawn and placed in a cooling rack. When the catalyst is sufficiently cool to be dumped without danger to the operator, the perforated plate is removed from the bottom of the tube and the catalyst is allowed to fall into a storage barrel beneath. The plate is then replaced and the tube is ready for charging with fresh “green” catalyst for another roasting cycle.

The gaseous decomposition products released from the catalyst during roasting pass into the furnace chamber and are released with the flue gases to the atmosphere in greatly diluted concentrations, thereby avoiding condensation of corrosive substances on the roasting equipment used or the release of fumes or vapors which might prove objectionable to the adjacent neighborhood.

A suitable green catalyst for roasting in my apparatus may be prepared as follows:

Make a mixture of equal parts of blue oxide of nickel, aluminum hydrate, and magnesia into a stiff paste with a concentrated solution of nickel nitrate containing 1% of caustic potash. Spread this paste in layers about 3/4" thick, cut it into cubes and dry at a temperature between about 212 and 250° F. The dried paste, broken into lumps, is then a suitable “green” catalyst to be used in the operation of my invention as already described.

For the purpose of this invention, I characterize as a “green” catalyst any substantially solid mixture of catalytic materials containing substances decomposable by heat with liberation of vaporized products of decomposition, such as oxides of nitrogen or carbon, water vapor, acids, and other products. I further characterize as a “roasting” process the process of subjecting a green catalyst to an elevated temperature sufficient to cause evolution of vaporized products of decomposition but insufficient to seriously impair the activity of the finished catalyst. I find a suitable roasting temperature for catalysts of the type described in the above example to be from 1600 to 1900° F., but other temperatures may be used, depending on the particular catalyst used.

My process is not limited to the use of air as a cooling gas but other gases and even steam may be used provided only that they do not exert a harmful action on the catalyst.

The invention is not to be limited to any specific details given merely by way of example or to any theory of the operation, but only by the following claims in which I wish to claim all novelty inherent in my invention.

1. An improved method of roasting green catalysts containing heat decomposable metallic nitrates in a furnace maintained at substantially constant temperature which consists in placing the green catalyst in a portable tubular vessel, slowly admitting said vessel into the heated furnace and simultaneously passing a cooling and flushing gas through said portable vessel over the catalyst whereby its rate of rise of temperature is retarded and without materially decreasing the temperature of said furnace.

2. In the preparation of a roasting catalyst from a “green” catalyst containing heat decomposable metallic nitrates which evolves corrosive products of decomposition on heating, an improved method of roasting comprising the steps of placing the green catalyst in a plurality of portable tubes external to a furnace maintained at a substantially constant roasting temperature, then slowly admitting the tube into the furnace while separately passing a continuous current of air at substantially atmospheric temperature into and through each tube during its admission into said furnace.

3. Method according to claim 2 in which steam is substituted for the air after the tube has been placed in the furnace.

4. An improved method of roasting catalysts for hydrogen production from heated furnaces comprising preparing a dried paste of catalytic materials, breaking this into lumps, placing the lumps in a portable tube external to a roasting furnace maintained constantly within a temperature range of 1600 to 1900° F., inserting said tube slowly into the furnace, passing a continuous current of air over the catalyst during the insertion, and substituting a current of steam for the air when the insertion is completed.

5. An improved catalyst roasting apparatus comprising a roasting chamber maintained at a substantially constant temperature, a hole in the top of said chamber, means for inserting vertically from above a tube containing green catalyst thereinto, a flexible pipe connected to the upper end of said tube for continuously admitting a cooling gas to said tube during its insertion into the furnace, and perforations in the bottom of said tube for releasing the gases into the furnace.

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