Lapery

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UNITED STATES STEEL CORPORATION
PITTSBURGH, PA.
BLAST STOVE INSULATION

As you know from our discussions earlier this week, we were informed by Mr. W. S. Debenham, Chief Ceramic Engineer for U. S. Steel, that a paper was to be presented at the AIME Meeting in Atlantic City on April 1st entitled, "Recent Improvements in Blast Furnace Stove Design" by Mr. Frank A. Berczynski, Vice President of Engineering, A. E. Anderson Construction Corporation, Buffalo, New York. Mr. Debenham further advised that there were some rather alarming disclosures in this paper regarding stove insulations. He requested that we meet with him to discuss this further.

Claire Harshaw, Sid Evans met with Mr. Debenham, John Topping, Mr. Debenham's assistant, and Mr. Bill Metzger, Blast Furnace Design Engineer.

They were all quite frank in saying they were quite concerned by some of the information contained in this paper. Not only because the great majority of their stoves are insulated with our SUPEREX, but also because they are, at the moment, in the final stages of planning their newest and the largest to date blast furnace at the Gary Indiana works. They are therefore very anxious for our comments on the information presented and our recommendations for a solution or alternative. Incidentally, they all spoke very highly of the author of this paper and he has apparently had many years experience in this business, not only with his present company, but with the John Mohr & Sons Company of Chicago.

Mr. Debenham was kind enough to have a copy of the paper made for me and in reading over it, it is obvious that it is the result of many years experience and much work. The paper, incidentally, is 30 pages long, with 17 pages of charts and diagrams.

Since I will not have an opportunity to have copies made nor discuss this with you, I would like to quote some portions of the paper for your consideration and advice. They will make plans to attend the AIME Meeting and would hope to be prepared to ask some questions and hopefully offer some alternates to Mr. Debenham. Unfortunately however, since we are tied up all this coming week with our sales meetings, it is going to be very difficult to do very much.

The following are excerpts which, I believe, cover most of the key points made by the author.

"Since about 1958, average stove refractory operating temperatures have been increasing. Accompanying this increase has been a period of unexpected stove shell failures, ranging from 360° horizontal cracks in the stove shell, opening gaps of 1/2" to 1", to severe bottom plate dishing; the latter at times resulting in premature stove bottom plate failure.--Stove Systems experiencing difficulty had one thing in common, i. e., the stove linings, in some cases new and in some cases old, were being operated at dome temperatures higher than that employed prior to the difficulty. The problem was, therefore, related in some way to temperature." (The author continues here for 2 pages describing assumptions that were made in the past regarding expansion, its effects and provisions made to allow for it. He then states that he feels this matter needs a reevaluation with today's operating conditions.)

"The majority of stoves in service throughout the U. S. utilizes insulating material between the stove ring or pilaster wall and shell which have compressibility characteristics similar to materials 1 and 2 shown in figure 11. (Assume to be curves on SUPEREX and IV Block.) It can be shown theoretically that the range of insulation compression required for most stoves in the U. S. operating at dome temperatures of 2300 F is approximately 5% to 10% - the specific range being a function of stove diameter in refractory materials. At these percentages, the radial shell pressure can be as high as 125 psi, assuming the shell does not yield under these pressures."

"The pressure created by the radial expansion of the refractory, coupled with their vertical expansion, raises the shell or creates a high axial stress if the shell is sufficiently restrained, through the friction that exists between the insulation and the stove shell."(A chart illustrates these forces) -- "In most stoves in the U. S. operating at dome temperatures of 2300 F, this "frictional drag stress" is in excess of 30 times the combined axial stresses resulting from shell dead load, wind, thermal differentials, and internal pressure.-- A close examination of the factors contributing to the "frictional drag stresses", indicates two possible economical methods of reduction. The friction factor, f, could be lowered; or F, the force due to pressure could be reduced by using a more compressible insulating material. The latter is most desirable since the accurate determination of the friction that exists between the materials in a hot blast stove in operating conditions is not extremely reliable. Until recently, a suitable insulating material with the temperature and compressibility characteristics necessary to accomplish the reduction of the radial pressure force, F, at reasonable costs did not exist. New mineral wool insulating materials can now be obtained from most major refractory manufacturers with the necessary properties. Figure 11 shows the percentage of deformation versus pressure characteristics for one such material, for 2 different thicknesses. -- "Figure 13 compares the thermal conductivity of a typical mineral wool insulation suitable for stove application with conventional insulating materials 1 and 2. As far as recovery is concerned, a 7" thick sample of mineral wool block insulation was subjected to a 10% deformation in 10 minutes. The sample returned to a thickness of 96.5% of the original thickness.--"Several stoves have been installed with highly compressible mineral wool insulations. The oldest of these insulations has been in service since 1964. These stoves have experienced less than 1/8" total movement of the bottom plate, maximum movement occurring at the dome temperature of 2300 F, and ambient temperature of 0 F."

This is basically his story. It certainly appears from the facts presented that there is a need for some means of absorbing the expansion and reducing the "frictional drag stress". However, I certainly don't think the answer is replacing SUPEREX with any mineral wool block that I know of and U. S. Steel people are of this same opinion. However, it does appear that some composite type of material might well be in order combining the temperature resistance and stability of SUPEREX and the compressibility or resilience of a fibrous material on the cold or shell side. I think we should, at once, determine if we can laminate SUPEREX and 1000^{o} Spin-Glas or 400 Series Spintex to offer for this application. Regarding the mineral wool material mentioned in the paper, at this point I don't know what material customer is referring to, but I don't know of any great improvement in these materials by any of our competitors and certainly none that I know of is suitable for a hot face temperature of 1900 F and certainly does not have the resilience described in the article after being heated and I'm convinced U. S. Steel people, at this point, feel the same way. However, I feel this paper is going to have great impact and we must be ready with some answers if we are to maintain our position in this field.

I would like to discuss this with you and all concerned at Research on Thursday.

J. A. Campbell, Jr.

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