Tip No. 2

Tip No. 2 can be helpful in classifying a pneumatic tool problem. In descaling a roll the operation is done very much in the same fashion as one would descale steel plate or nick concrete. Three years ago this operation was quite hazardous because of potential accidents associated with the breakage of chisels. Lacerated or broken fingers were common because of the inevitable exposure of a man's hand when an end of a chisel broke off.

To understand the fundamentals underlying this failure, we measured from the origin of the failure to the end of the chisel as recommended by the suggestion for analyzing failures. Results of measuring 360 such failures produced a frequency distribution which told us immediately that the failures did not occur at the same spot. They varied over a two-inch length. *Tip No. 2* suggests that this is a metallurgical problem. Therefore, we investigated the factors that we thought were related to this failure.

We learned that each chisel was subjected to bending stresses due to off-center impact and these bending stresses started failure in the surface layers. The exact location of each failure was dictated by minute irregularities in the surface. Each chisel had on its surface an unavoidable layer called a decarburized layer and it is a recognized fact that decarburization does not resist repeated stress as well as material not decarburized. We were faced with the problem of either removing the decarburized layer or strengthening it. We decided that strengthening it would be the most practical and we chose to try shot peening the surface of the chisels. By this method, the surface of the chisel is sprayed with the steel shot which closes up any pits in the surface and induces favorable compressive stresses in the decarburized layer.

Our first tests were conducted on a lot of 1,000 chisels. One-half of the lot was the so-called standard chisels that served as a control group that would give us an accurate picture of the performance of unpeened chisels. The remaining half of the lot was shot peened to strengthen the surface layers.

With 500 standard chisels after 14 days service, there were 360 potential accidents, with 360 broken chisels and 140 dulled ones. With 500 shot peened chisels after 39 days service, there were only 10 potential accidents with 10 broken chisels, 13 broken through the stamp mark, and 477 dull ones. While this was an encouraging improvement, we did not stop development work. We learned that by revising our peening technique slightly, we could reduce the 140 dull chisels in the standard chisel pile to 2. Our records show that potential accidents have dropped from about 300 per 1,000 man hours to less than 1 per 1,000 man hours.

Broken Gouges

The same reduction in potential accidents was reproduced in another tool known as the gouge. The origin of failure varied considerably as was indicated by the length of the broken tips. *Tip No. 2* provides the clue as it did in the case of the chisels and, in this instance, too, hundreds of potential accidents have been eliminated by shot peening the gouges.

Stripper Tongs

As with the preceding cases of failure of pneumatic tools, the same techniques are applied to analyzing failures in heavy equipment. A device used to remove ingots from their molds is known as a stripping tong. Our records show that many of these tongs have spread or have broken suddenly in the past. Fortunately, we did not have any accidents; but no one could guarantee immunity under the circumstances with which they were used. In examining the failures in accordance with the suggestion advanced, we learned that the origin of failure varied widely. Some failures were near the lower ends, some were near the pins, and some were midway between the pins and the end.

Tip No. 2 suggested a material investigation. We investigated the stresses that could be set up in the tongs under various loads, particularly when sticker ingots were being removed. We learned that the material should be considerably stronger to withstand normal operation. We immediately changed the material specifications from annealed plain carbon steel to heat treated alloy steel and almost overnight improvement was noted.

Instead of spreading at the gripping surfaces, the new tongs resist spread. But, more important, is the elimination of breakage. In over two years of service there has not been a case of potential accident.

Axle Failures

Axle failures on rolling stock constitute one of the most serious potential accidents we have to deal with. When an axle breaks, no one can predict final consequences. Fortunately, we have never had a lost time accident due to such failures but we did have a potential as high as 12 in one year.

As many as 12 broken journals off cars occurred in one year. They were all at the same location, the radius at the end of the journal. *Tip No. 1* suggested a design problem.

We studied the design and learned that the ⅛ inch radius at the end of the journal was a stress raiser and it actually increased stresses by nearly 2 times. The responsible factor was obvious to us as investigators, but we felt that we needed visual proof to support our theories. It occurred to us that if the theory was correct, then both ends of the axle were exposed to the same stress levels and, although it appeared that only one journal was broken off, the "unbroken end" should be cracked.

To prove this point, we examined the "unbroken" journal and saw nothing. Realizing that cracks of this nature are too tight to see with the naked eye, we wrapped an ordinary welding lead around the "unbroken" journal and passed current through the lead. This magnetized the axle and after sprinkling magnetic powder on the journal we brought out the clinching evidence. Here was proof that the potential accidents were originating in the radius. We redesigned the axles and after three and one-half years of service, not a single failure has been reported.

Shear Knife Breakages

Shear knife breakages are one of the worst kinds of potential accidents because of the possibility of flying pieces of steel. All of the knives were in operation cutting steel beams. Some of the knives were spalled and some were broken. When the knives are examined carefully, the origin of failure is found at a different location, thus indicating a metallurgical problem.

A careful study of this problem showed that high frictional heat was being developed during cutting operations and caused tiny heat checks to open upon the surface and finally leading to these serious potential accidents. By changing the analysis of the material to provide heat resistance we have completely wiped out these failures providing safer operating conditions for the shearmen.

If we have improper balance of material, design, and load, we can expect unpleasant consequences, including potential accidents. By applying *Tip No. 1*, or, *Tip No. 2*, we have shown how it is possible to achieve proper balance of material, design, and load, and bring about several pleasant consequences, including reduced potential accidents.

There Is a Man in the House

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My discussion is the story of supervisory safety training in the Engine and Foundry Division of the Ford Motor Company.

Before we get into the details of that program you might like to know something about our division and its relation to the overall company operation.

The engine and foundry division is primarily responsible for the manufacture of all automotive engines used in the company's passenger and commercial vehicles. This includes the Lincoln, Mercury and Ford overhead-valve V8 engines and the Ford "6" overhead-valve in-line engine. We also build a complete line of industrial engines as well as a tank engine for the Armed Services. We have eight operating plants, four of which are foundry operations and the remaining four are engine machining and assembly plants. Our employment approximates 33,000 employees at the present time with a very wide range of job classifications.