Change-out of a Primary Reformer Harp

Of the change-out procedures available, it was decided to fabricate the harp replacement in three sections, drop these into position through the roof, and make two field welds on the bottom manifold in the furnace.

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Because of numerous problems in the initial start-up, a Canadian Industries' primary reformer had to be shut down on several occasions. From the information now available we know that thermal cycling had affected the life and reliability of the reformer tubes and risers. During a two week turnaround in October 1971 the "A" harp (the one closest to the secondary) was changed-out of the primary reformer. The factors which led to this decision are listed below:

1. In March 1970, after approximately 20,000 hr. of operation, "A" riser ruptured forcing a shutdown.
2. Two additional tube failures during 1971.
3. Cracked top welds in three catalyst tubes which had to be replaced.
4. The thermo-couple was not operating properly for an extended period, which may have allowed the harp to be operated at temperatures above that which is considered normal for our operation.
5. "A" harp is next to the wall and hence affected by radiated heat.
6. Examination of section taken from the failed tubes revealed that up to two-thirds of the useful life of the tubes had been expended, and that the tubes had experienced intermittent temperatures above 180°F.
7. Extensive repair required to the weld-o-let to bottom manifold weld due to cracking.

Methods investigated

Once the decision to replace "A" harp was made, a method for the change-out had to be devised. A number of alternatives were available and investigated. Since most of the tube failures were concentrated in the west half of the harp, one possible solution was to replace just this section. This was rejected because the reliability of the completed harp would be questionable since the remaining life of the tubes not replaced could not be completely defined.

Another approach would be to assemble the harp in the furance, i.e., weld the tubes to the bottom manifold in situ. This would eliminate any work on the arch, but the amount of welding and the questionable results would more than offset any gains of reduced work requirements on the arch.

A third method considered was to fabricate the harp in three sections, cut out a section of the reformer side wall to the full height of the furnace, and slide the section into position and make the necessary field joints. This method was rejected because of the amount of work involved with the floor and side walls, which included cutting of main support beams.

The final method considered, and later decided on, was to fabricate the harp in three sections, drop these into position through the roof, and make the two field welds on the bottom manifold in the furnace.

Since we had not experienced any previous difficulties with the transition section from the riser to the transfer line, it was elected to leave this section for replacement at a later date in conjunction with the transfer line. The replacement, therefore, included only the harp, pigtails, springs, and inlet manifold including new supports.

The inlet manifold was included because lack of sufficient supports had caused the manifold to bow early during the start-up periods. At that time, two additional supports were added to each manifold.

New design concepts included in the change-out are:

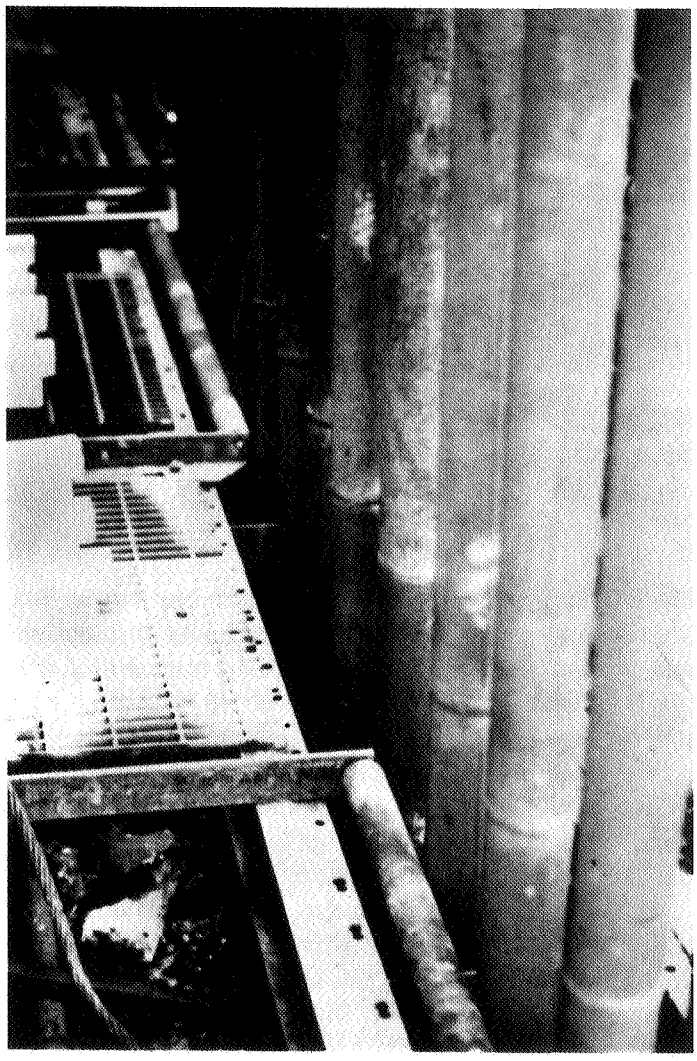
1. Bored catalyst tubes having dimensions of 2.8 in. ID and 0.610 in. MSW.
2. The welding of the weld-o-let to the bottom manifold and the tubes to the weld-o-lets using the T.I.G. process with Inconel 82 wire.
3. Constant bottom manifold.
4. Soft pigtail design and corresponding springs.
5. New inlet manifold sliding supports.

The design detail for the last three items was supplied by the M.W. Kellog Co.

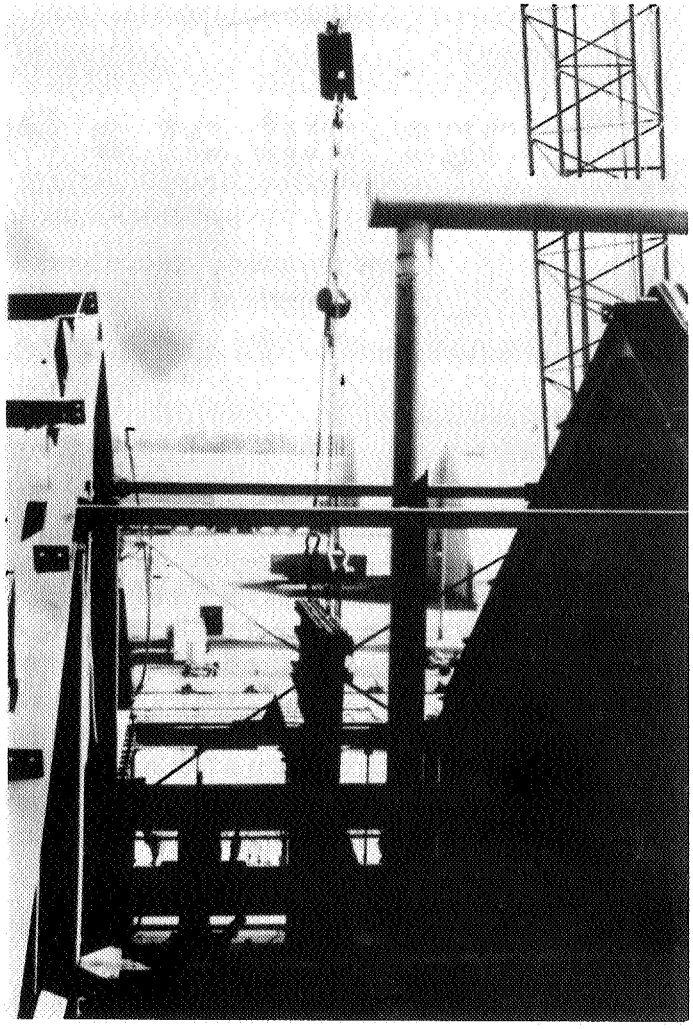
The job was scheduled for a normal two week turnaround. The plan called for two 10 hr. shifts, the second shift consisting of a skeleton crew for the first week and then one shift for the second week. All work, excluding the crane work, roofers and brick work, was to be done by C.I.L. maintenance. The entire job was planned using critical path techniques.

Changeout Operation

All required equipment and tooling was moved to the job site prior to the plant being shutdown. A reference mark was made on the transition cone after the furnace had



Location and spacing of the rollers.



Removal of the east section of the old harp. Note the clearance between the beam and tubes.

cooled down and before any work was started. The water was still in the water jacket at this time. So that we could determine how much the transfer line would "lift" after the riser was cut and make the necessary compensation for this when installing the new riser.

The first task was to remove the transite roof slabs and steel work supporting the roof section. Because of the support arrangement, the bay above the two harps had to be removed so, in fact, two adjacent harps could be removed without any additional removal of the roof. While the work on the roof was in progress, other jobs below the area were curtailed for safety reasons.

In addition to the roof slabs a section of the side wall slabs had to be removed to allow for the removal and installation of the inlet manifold.

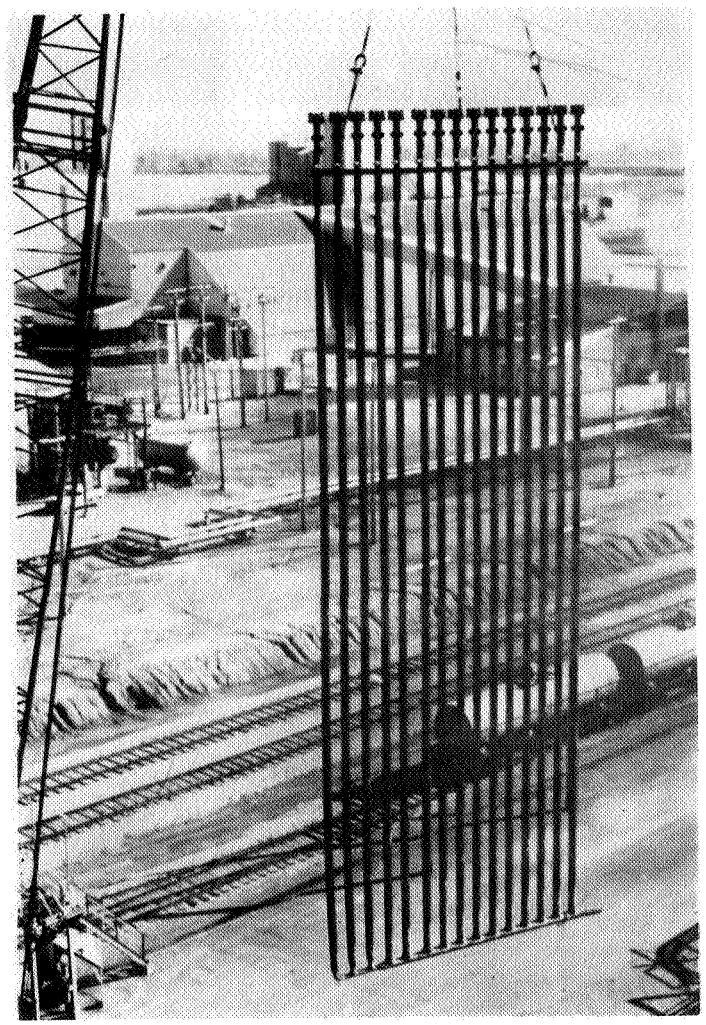
Once the roof work was completed work could safely proceed to remove the insulation for the removal of the pigtails and inlet manifolds. Removal of the pigtails was facilitated with a cutting torch. Once cut, they were lowered to the ground.

The next stage involved the removal of sections of the arch brick. It is important to leave the spacer brick in position every 4- to 6 ft. to prevent any chance of the arch moving in and falling. In addition, a steel plate was installed against the face of the bricks and tied back to the support beams with steel members. This was deemed necessary since even a small jar of the bricks when removing or installing the harp could have serious consequences. We also installed 3 ft. long rollers spaced as required along the length of the harp, just above the arch, bolted with slotted holes to the arch support beams. This was to assist during the removal and installation phase, and also to offer some protection for the arch from accidental bumps.

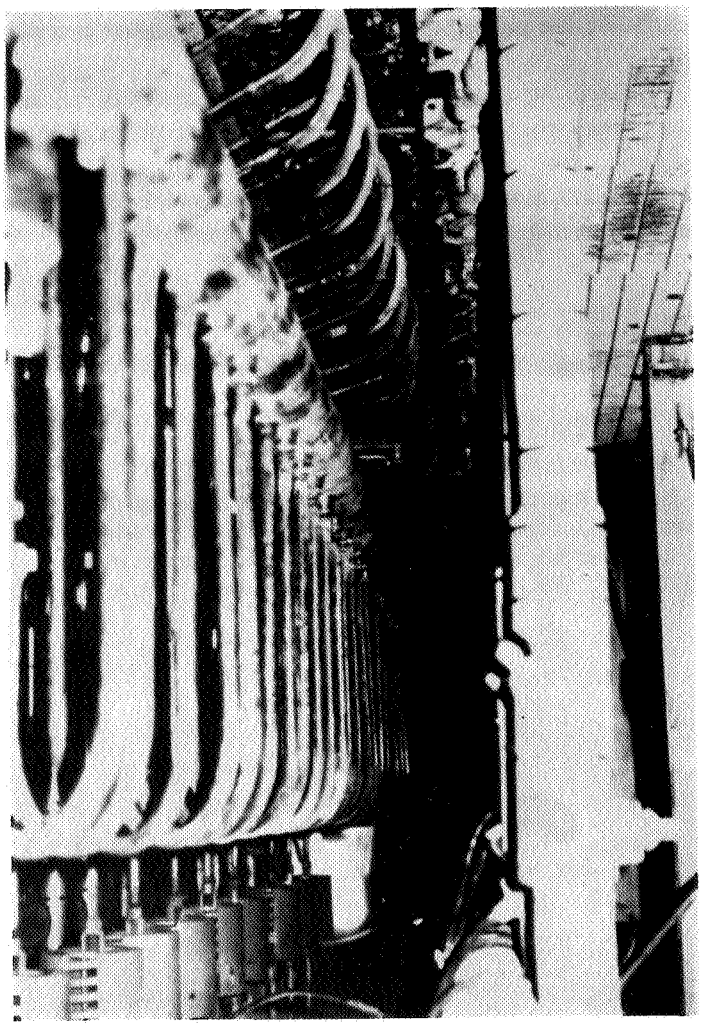
The harp was next supported with chain falls and the spring hangers removed and lowered to the ground. Once the harp was fully supported by the chain falls, the bottom manifold was cut at the field joints and the riser at the bottom weld.

The removing of the harp sections was then started. It should again be pointed out that the spacer bricks were left in position until the last possible moment and then replaced as soon as the section had cleared the arch. Some difficulty was experienced in the removal of the harp sections when the catalyst tube flanges hung up on the overhead beam. To overcome this problem, chain falls were used to take a side pull with the harp tubes resting on the rollers to prevent damage to the furnace arch. The same problem presented itself when the new harp sections were installed, but was overcome in the same manner.

To prevent having to clear under the effluent chamber and steel supports, the center section was cut in two at the riser. This made removal of the smaller sections much



One section of the old harp.



New pigtails and spring supports.

simpler.

Once all of the old harp was removed, the reverse procedure was used to install the new one. In order to provide for easier passage of the center section under the effluent chamber and supporting steel, and leave the floor and tunnels intact, this section was installed without the carbon steel top works on the catalyst tubes. Once the section was in position, it was jacked up so that the welders could make the welds joining the carbon steel top works to the catalyst tubes with ease. All of these welds were 100% X-rayed.

With the three harp sections located in the furnace, supported on chain falls, and the carbon steel top works welded to the center 12 catalyst tubes, work was started on installing the new spring hangers and the new inlet manifold. The new designed supports for the inlet manifold were installed at this time.

The harp, still supported by chain falls and jacks, was leveled in preparation for making the field joints. At this time, the new pigtails were positioned and welded. Four of the pigtails required re-vamping in the field in order to clear the inlet manifold supports. All of the pigtail welds were dye checked to verify the quality of the welds. Insulating began as soon as inspection had accepted the welds.

After the field welds on the bottom header were made, work on insulating the manifold began. The bottom weld on the riser was also made at this time.

To help check for any movement in the harp during operations, a reference wire was stretched taut, between angle iron posts, approximately 4 in. above the blind flanges.

The final operation was to support the harp by the spring hangers and make the top weld on the riser. Because the total weight of the new harp is greater than the old design, some changes to the spring settings of the transfer line springs were required to compensate for this additional load. Changes were made as per M.W. Kellogg's recommendations.

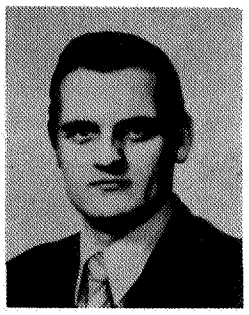
Summary

The job was completed in the allotted time and progressed as planned. One error made was to set the spring hangers without any water in the water jacket of the transfer line. This was later discovered and the springs had to be re-set after filling the water jacket.

During the first week the day crew comprised an average of eight men while the night crew comprised four men. At the end of the first week the night crew was discontinued while the day crew was reinforced with welders and insulators as required. The maximum number of welders used at one time was four. The total man-hours required to

complete the change-out was 2,200 and the labor cost was $12,000.

We will be changing out additional harps this fall and will be approaching the change out in basically the same manner, but with a few changes, which will include pre-insulation of the straight lengths of the pigtails. sections of the mixed-feed line and the bottom manifold. #



EMRICH, J.

DISCUSSION

ANON: How did you determine that two-thirds of the life had been consumed in these tubes? That's a very tricky determination, and I'd like to know how you did it.

EMRICH: We had sent sections of tubes from a previous shutdown to Battelle Memorial Institute, in Columbus, Ohio and the results of their tests indicated that two-thirds of the tube life had been used.