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USE OF MIXING SLUGS FOR
TUBE CORROSION CONSIDERATIONS

AUTHOR

S. M. Graves

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IRRADIATION PROCESSING DEPARTMENT

May 13, 1959

C. G. Lewis, Manager
C Processing Sub-Section
B-C Reactors Section

USE OF MIXING SLUGS FOR
TUBE CORROSION CONSIDERATIONS

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By Authority of DS Lewis,
CG-PR-2, 1-6-94
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A recent extensive analysis⁽¹⁾ of C Reactor's tube corrosion, probolog, and tube examination data by N. R. Miller has resulted in an improved correlation of corrosion indices, "R" values, outlet water temperatures, and "between the ribs" tube corrosion at C Reactor. This improved correlation permits a more accurate estimate of tube life and tube replacement rates at C Reactor than was previously possible. It also facilitates evaluation of methods for reducing tube corrosion rates. Miller's document suggests three possible methods for retarding tube corrosion: the use of a larger slug, shifting of the charge upstream, and the use of a mixing slug. Of the three, the use of the mixing slug appears to be, by far, the most attractive.

A detailed analysis of the benefit of mixing slugs use at C Reactor from tube corrosion considerations has been made. It appears that the use of mixing slugs in the central zone will result in an average savings of 140 tubes per year which would otherwise require replacement. This potential savings, of course, will be partially reflected in a reduction of tube replacement requires in 1961 and 1962 as well as in benefit for the near future. The mixing slug is of slight benefit in tubes have a corrosion index less than 10. The value of the mixing slug in reducing tube corrosion increases

(1) HW-60234, "Uniform Process Tube Corrosion with Specific Application to C Reactor," N. R. Miller - to be published.

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with corrosion indices as shown in figure 1. At the higher corrosion indices, the corrosion rate may be reduced by a factor of two. Thus, tubes that would normally require replacement in 1960 could be deferred until 1961 with mixing slug use. If mixing slugs were used throughout the entire life of a given tube, it is estimated that the tube life would be increased by 25 to 30 per cent. This is illustrated in figure 2.

The dollar value of production gain from decreased downtime due to tube replacement would be approximately \$400,000. This does not include savings in actual material and labor costs. It is estimated that associated costs including 35 ih reactivity loss, incremental increase cost of mixers, and increased throughput would amount to approximately \$60,000 per year. The potential gain appears well worthwhile, particularly when delaying tube replacement requirements at C Reactor may be additionally advantageous when zirconium tube program schedules are considered.

Determination of the optimum mixer location, based primarily on tube corrosion considerations, indicates that the position seventh from the rear would result in the greatest increase in tube life. This location should also substantially increase the TOA boiling limits which we understand may become a problem toward the end of the year. The following were also considered when evaluating mixer location:

1. TOA Corrosion Limits

It was assumed that TOA corrosion limits will be rescinded as a Process Standard requirement in the near future and that mixer location should not be influenced by this consideration.

2. Rupture Relationships

Rupture experience to date together with theoretical calculations indicate that hole failure rates may be several times higher than annulus failure rates.

Under these conditions, the use of mixers as a deterrent to ruptures may have small effect as slug hole temperatures will remain essentially unaffected by a mixer. However, there is a possible advantage from the flux standpoint, as the use of mixing slug in the rear of the column will tend to skew the flux to the front of the reactor. This is definitely desirable from a rupture control standpoint.

Additional rupture experience at C Reactor may dictate further consideration of rupture relationship in selecting a mixing piece location. Future adjustments of a mixing piece location will be recommended if they are indicated.

At our request, an underwater slug press has been designed by Mechanical Development "B" Unit and is ready for installation in C Basin. Compressive strength data on irradiated Mark VI mixers will be available within the next two weeks. It has been estimated that 19,000-20,000 pounds may be applied to irradiated Mark VI slugs before they will stick in a C Reactor process tube. It would be desirable to get confirmation of this estimate prior to initiation of large scale use of mixing slugs in natural tubes.

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Subject to satisfactory results from the above test, it is recommended that Mark VI mixing slugs be used in a position seventh from the rear (6N-1M-26N) in all central zone natural tubes at C Reactor and that the necessary procurement of Mark VI mixing slugs be initiated.

We will be pleased to discuss estimated benefits and associated "costs" with you in greater detail if you desire.

SM Graves:md

Process Engineering Unit
Research and Engineering Section

APPROVED:

J. F. Music, Manager
Process Technology Sub-Section
Research and Engineering Section

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FIGURE 1

CORROSION RATE
AS A FUNCTION OF
CORROSION INDEX

(Illustrative Example)

1040 KW

45 gpm flow

17° C Inlet

(Based On Correlations In HW 60356)

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