15/05/003/006

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CONOCO INC.

DATE 2/11/92

MOBIL OIL CORPORATION

RESEARCH DEPARTMENT

TECHNICAL MEMORANDUM NO. 66-8

# THE DEVELOPMENT OF A RISER-TYPE AIR DISTRIBUTOR FOR LARGE SHALE IN RETORT NO. 2 - COMMENTARY ON TECHNICAL FILM NO. 66-3

ANVIL POINTS OIL SHALE RESEARCH CENTER

Rifle, Colorado

October 31, 1966


Work By:

T. C. Lyons
L. J. Skowronek

Approval:

R. H. Cramer
Program Manager

Commentary By:

T. C. Lyons

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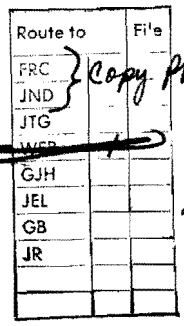




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The primary object of the Anvil Points Oil Shale Research Center TECHNICAL MEMORANDUM is to advise authorized personnel employed by the Participating Parties[1] that various activities are in progress or that certain significant data have been obtained within the Research Center.

These TECHNICAL MEMORANDA have been prepared to provide rapid, on-the-spot reporting of research currently in progress at Anvil Points. The conclusions drawn by project personnel are tentative and may be subject to change as work progresses. The TECHNICAL MEMORANDA have not been edited in detail.

[1] Mobil Oil Corporation, Project Manager

Humble Oil and Refining Company
Continental Oil Company
Pan American Petroleum Corporation
Phillips Petroleum Company
Sinclair Research, Inc.

# THE DEVELOPMENT OF A RISER-TYPE AIR DISTRIBUTOR FOR LARGE SHALE IN RETORT NO. 2 - COMMENTARY ON TECHNICAL FILM NO. 66-3

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TECHNICAL FILM 66-3

THE DEVELOPMENT OF A RISER-TYPE AIR DISTRIBUTOR FOR LARGE SHALE IN RETORT NO. 2

Approximate length of film - 200 feet
Approximate projection time - 8 minutes

## I. SUMMARY

In the demonstration run series B-817[1], the eight-riser air distributor (Type XI) performed successfully in Retort No. 2 with 3/4 to 1 1/2 inch shale. However, with the larger shale sizes (1 to 3 inch and 1 1/2 to 3 inch), the shale flow was very erratic as evidenced by fluctuations in roll feeder speed and Gamm-O-Tron level control. Flow studies in a miniature plexiglass model of Retort No. 2 (1/6th scale) confirmed the erratic shale flow and the presence of large voids in the bed in the region of the air distributors. Therefore, a model study was initiated to develop a riser-type distributor design which would give good shale flow while maintaining adequate air distribution.

The study revealed that four modifications were necessary to facilitate shale flow. These changes - illustrated schematically in the attached figure - were as follows:

1. The number of risers was reduced from eight to four.

2. The horizontal headers feeding the risers were relocated to increase wall clearance.

3. All angled pipes were eliminated by positioning the risers directly above the horizontal headers. (This emphasized shale flow at the expense of gas distribution since one-half of the air was injected into one-third of the retort area).

4. Contour of the horizontal headers was improved by providing a sharp leading edge rather than a blunt, round top. The width of the header was reduced to two inches compared to the four inch pipe used previously.

With the four-riser design, the flow of the larger shale through the model was comparable to that of 3/4 to 1 1/2 inch shale with the eight-riser configuration. This vastly improved shale flow was also observed in the subsequent operation of Retort No. 2 with the four-riser design (Type XV) in Demonstration Series B-952

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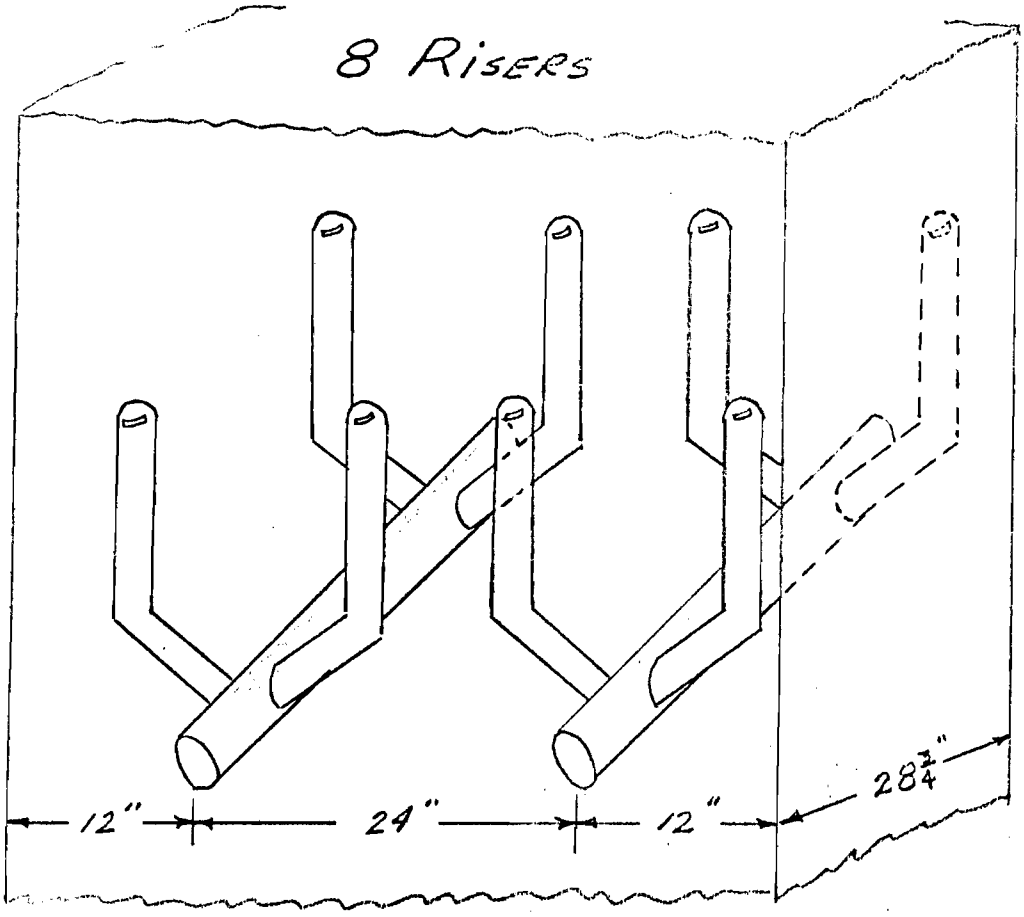
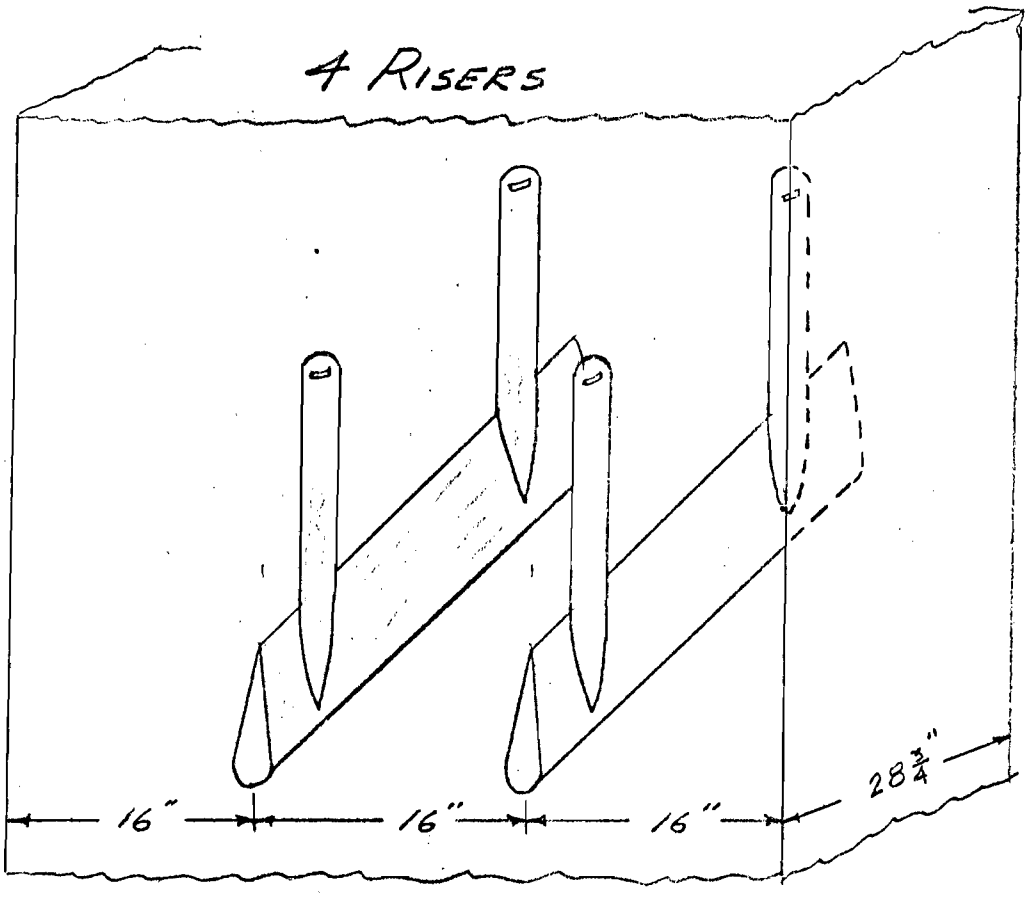
[1] Technical Memorandum No. 66-2, Demonstration of Yield and Operability Retorting 3/4 to 1 1/2 inch Oil Shale at 500 lbs/(hr)(ft$^2$) in Retort No. 2, March 21, 1966.

# Air Distributor Configurations in Retort No. 2




TCLYONS 7-66

Motion pictures were taken of the Retort No. 2 model in operation during these studies. The resulting film presents a very vivid illustration of the problem and the solution. In addition, this film is an excellent example of the use of miniature models to investigate and solve shale flow problems in full scale units.

## II. COMMENTARY

To assist in the synchronization of the commentary and the film, the titles are reprinted here just as they appear in the film.

TITLE

| SCALE MODEL |
| --- |
| RETORT NO. 2 |
| SCALE 1" = 6" |

### A. Overall View of Model (Front View)

The front view of the model shows the orientation of the retort internals across the eight inch (simulated 48 inch) dimension.

### B. Overall View of Model (Angle View)

This angle view includes the 4 3/4 inch (simulated 28 3/4 inch) dimension and provides a much clearer picture of the retort internals.

### C. Closeup of Bottom Section

The sloping outlet of the retort, the roll feeders, and the recycle gas distributor are shown in this view. In Retort No. 2, the recycle distributor is a six inch pipe with a contoured hat to streamline the profile of the leading edge and improve shale flow.

### D. Closeup of Air Distributor Region

A slow pan up to the air distributor region shows the general orientation of the distributor hardware. This is a scale replica of the assembly used in the Demonstration series B-817 which has been designated air distributor Type XI. It consists of two main headers (four inch pipes) and angled manifolds leading to the eight risers (two inch pipes). Note that the center lines of the two main headers are spaced 24 inches apart and 12 inches from the walls.

E. Closeup of Air Distributor Assemblies

In this sequence the distributors were removed from the model to emphasize the details of the assembly. One of the assemblies is then rotated to give a "shale's eye" view as the particles pass down through the retort and enter the distributor region.

TITLE

| MODEL RETORT NO. 2<br>FLOW OF<br>3/4 - 1 1/2 INCH SHALE |
|---|

The following sequences show the flow of shale through the model. In this type of study the model is filled with shale which is scaled down by 1/6th. The surface is leveled and the shale is drawn down slowly. Changes in the surface profile indicate distortions in flow.

F. General View of Shale Flow Through Model - Simulated 3/4 - 1 1/2 Inch Shale With Eight Riser Assembly

The surface profile remains uniform until the level approaches the top of the distributors. At this point the center begins to run faster and shortly thereafter, the sides begin to speed up. (This phenomenon will be seen better in the closeup sequence that follows).

TITLE

| MODEL RETORT NO. 2<br>FLOW IN REGION<br>OF<br>AIR DISTRIBUTORS<br>3/4 - 1 1/2 INCH SHALE |
|---|

G. Closeup of Flow in Region of Air Distributors - Simulated 3/4 - 1 1/2 Inch Shale With Eight Riser Assembly

This sequence focuses on the critical flow region which is right at the distributors and supporting hardware. It

will be noted that the bed is compact; there is no evidence of large voids or any general loosening of the bed as it flows through this region. (There is a void which forms below the main headers as would be expected). The faster flow in the center and walls is readily apparent as the level comes within several inches of the tops of the risers. (This is equivalent to 12 or 18 inches in the full scale retort). This simply indicates that the hardware is impeding flow but not to the extent that voids are formed or erratic flow results. Furthermore, the success of the demonstration run indicates that this type of distortion can be tolerated.

TITLE

| MODEL RETORT NO. 2<br>FLOW OF<br>1 1/2 - 3 INCH SHALE |
|---|

H. General View of Shale Flow Through Model - Simulated 1 1/2 - 3 Inch Shale With Eight Riser Assembly

The difference in flowability of the large shale through the distributor zone is obvious in this general view but the action is much more pronounced in the closeup that follows. (It should be noted that the overall jerky-style flow with the large shale is the result of erratic flow through the model roll feeders).

TITLE

| MODEL RETORT NO. 2<br>FLOW IN REGION OF<br>AIR DISTRIBUTORS<br>1 1/2 - 3 INCH SHALE |
|---|

I. Closeup of Flow in Region of Air Distributors - Simulated 1 1/2 - 3 Inch Shale With Eight Riser Assembly

This closeup view shows the general loosening of the bed and the large voids which form in this region. In addition it reveals the slow particle movement between the risers compared to the flow in the center and walls. Lateral movement of particles into the center is also quite

apparent. As the surface level approaches the top of the distributors, this distortion results in the characteristic dip in the center and at the walls. The need for improved flow is quite obvious from this film sequence.

TITLE

MODEL RETORT NO. 2

RISER DESIGN FOR

LARGE SHALE

J. Riser Design For Large Shale

The necessary modifications required to facilitate the flow of large shale were outlined earlier in this memorandum and illustrated in the attached figure. The film shows the four riser design both removed from the model and in place. The "shale's eye" view of the modified header assembly reveals the streamlined nature of the hardware. The headers were now thin and sharp and all horizontal arms were eliminated by placing the risers directly on the headers.

TITLE

MODEL RETORT NO. 2

FLOW OF

1 1/2 - 3 INCH SHALE

4 VERTICAL RISERS

K. General View of Shale Flow Through Model - Simulated 1 1/2 - 3 Inch Shale With Four Riser Assembly

See discussion below.

TITLE

| MODEL RETORT NO. 2<br>FLOW IN REGION OF<br>AIR DISTRIBUTORS<br>2 MANIFOLDS 16" CTR. TO CTR.<br>2 RISERS/MANIFOLD |
|---|

L. Closeup of Flow In Region of Air Distributors - Simulated 1 1/2 - 3 Inch Shale With Four Riser Assembly

The general and closeup sequences reveal the striking improvement in the flow of large shale through the modified distributors. There is a significant reduction in large voids and the bed remains much more compact. The lateral movement of particles in the combustion has been minimized and the flow is primarily vertical. Consequently, there is no tendency for the surface to dip as the level passes the top of the air distributors.

The final sequence shows an extended riser assembly compared to one of standard height. The extension is used as a means of increasing the bed depth in the bottom zone of the retort without changing the physical location of the main headers. Since the larger shale requires the increased bed height in the bottom section, the extended riser version (18 inch extension) was designed and installed in Retort No. 2. This distributor was used during the Demonstration Series B-952.