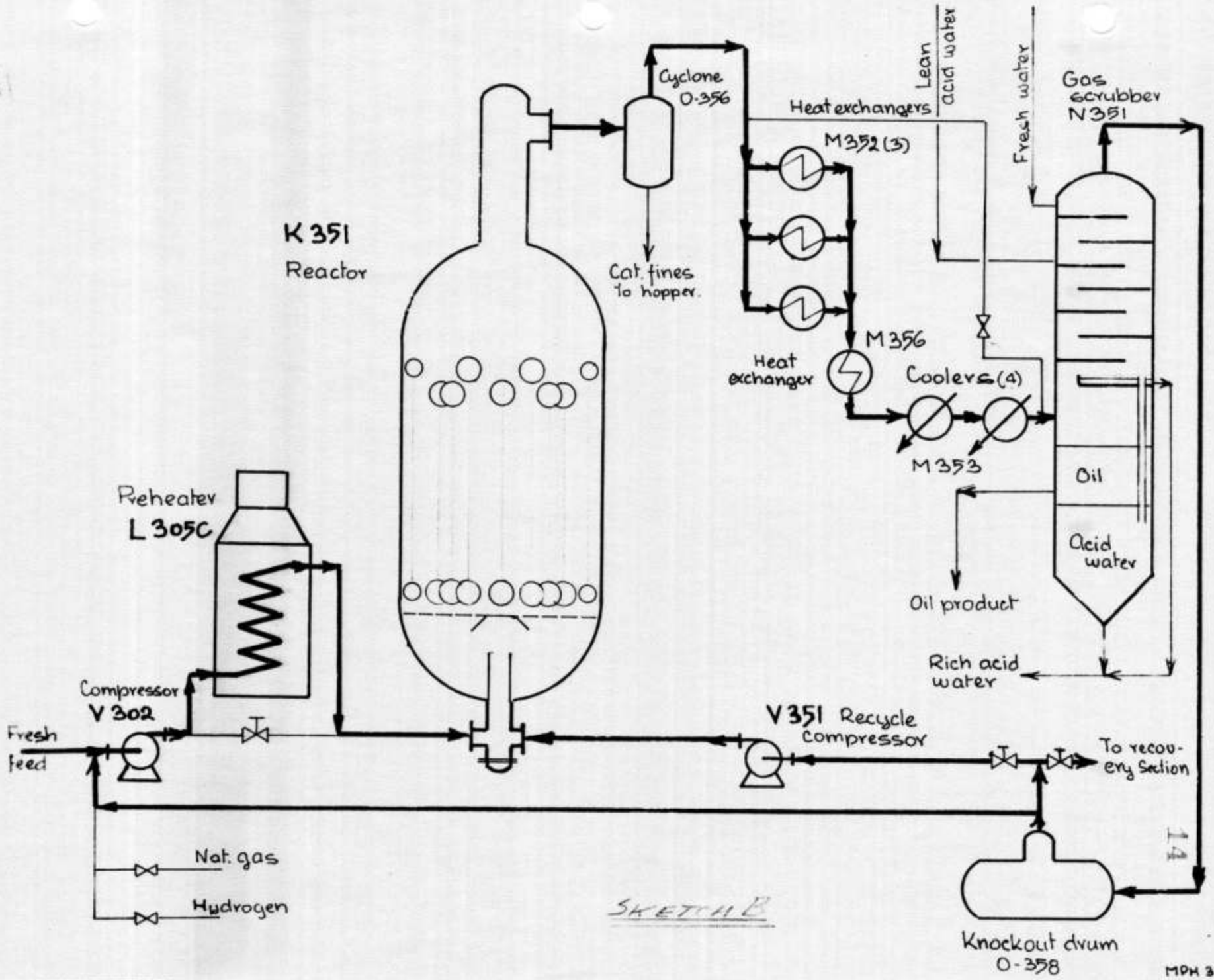
Reactor Operations

Before attempting to analyze the Brownsville data it is well to briefly review the operating procedures used on the reactor system.

The following Sketch B is a simplified flow diagram of the Reactor System. Su pose we start with the reactor in operation and about to come down.

A. Catalyst Stripping After Shutdown - Circulation

First the synthesis gas feed is shut off at the fresh feed compressor (V-302) section. The compressor V-302 will then be on recycle gas alone, supplemented by the Nat. Gas used for Aeration, about 55,000 SCFH and an additional 45,000 SCFH or so of Nat. Gas admitted to the V-302 suction when the Syn. Gas is cut off. The recycling rate is maintained to hold a lineal velocity thru the bed of 0.6 ft/sec with a minimum of 0.4 ft/sec to insure maintaining


K 351
Reactor
Cyclone
0-356
Cat. fines
to hopper.
Heat exchangers
M352 (3)
Lean
acid water
Fresh water
Gas
scrubber
N351
M356
Heat
exchanger
Coolers (4)
M353
Oil
Acid
water
Oil product
Rich acid
water
Reheater
L305C
Compressor
V 302
Fresh
feed
V351 Recycle
compressor
To recov-
ery Section
Nat. gas
Hydrogen
Knockout drum
0-358
SKETCH B
MPH 3-28

fluidization. The flow will be from the V-302 compressor thru the steam superheater L-305C (now used all the time as gas htr.) thru the reactor, the M-352 & M-356 exchangers, the M-353 cooler and then thru the Gas Scrubber N-351 and thus back to the V-302 suction. The V-351 recycle compressors will be shut down.

During stripping, the system pressure is reduced to about 100# and the reactor effluent temperature is held at 650-700°F. without exceeding 800° on the L-305C outlet. To maintain the bed temperature at this level the steam bundles have to be cut out of service. When the mass spec. analysis shows 90 to 94% CH_4 in the tail gas the stripping is considered complete.

The reactor temperature is then reduced to 270 to 300°F. by lowering the L-305C heater outlet. The acid water is then cut out of the gas scrubber (N-351) and city water only is used. After displacing the water in the acid water line to Stanolind for one hour the water from the gas scrubber is discharged to the pond.

If the catalyst is to be continuously circulated between runs, the conditions described in the previous paragraph are the ones used except that the reactor pressure may be lowered to about 80#. The rate required to maintain a lineal velocity of 0.6 ft/sec at 80# press. and 300°F. is about 1,800,000 SCFH.

Starting From Scratch

When coming up from a dead stop the same method of circulation is used except that the bed temperature is held at 500 to 700°F. while adding the catalyst to the reactor.

Unloading Reactor

The same circulation procedure (at 300°F.) is also used when catalyst is unloaded from the reactor. After all possible catalyst has been removed in this manner (thru bottom center outlet)

the circulation is stopped and the reactor washed with hot water before unheading. When the reactors are opened several tons of catalyst are always found packed between the tubes. This has to be removed by hand prodding.

Reduction Before Startup

With the reactor circulating Natural Gas as described above, the reactor temperature is raised to 700-725°F. and the pressure increased to 200# press. while raising the recycle rate and Nat. Gas input as necessary to maintain a lineal velocity of 0.6 ft/sec. This requires a rate of about 2,800,000 SCFH.

Hydrogen is then cut into the V-302 suction at the maximum rate of production, about 20,000 SCFH and the Nat. Gas is cut out. Aeration is maintained by recirculation in the separate (reciprocating) compressors (V-352). After about 48 hours the hydrogen concentration in the system will have reached about 40% and reduction is considered completed. In some runs where in a hurry to get started this time has been cut to 12 hrs. with only 30% H_2 concentration attained.

Nothing but city water is used in the gas scrubber N-351 during reduction.

Carbiding

Prior to the last three runs #15, #16 and #17 a carbiding step has been added after reduction. This is accomplished by simply shutting off the hydrogen and substituting synthesis gas from the generator with reactor at 650 to 700°F. and 250# pressure, synthesis gas is added to the V-302 compressor section at a rate of about 50,000 SCFH and is increased by that amount every 15 minutes until a total of about 700,000 SCFH is being added. This condition is maintained for about 20 hrs.

Shortly after the start of syn. gas admission acid water washing is started in the gas scrubber N-351.

Start Up

The normal starting up procedure is essentially the same as that described above for carbiding except that the increase in syn. gas admission rate is not interrupted until the full desired rate, usually 3,000,000 SCFH has been attained. Also as the syn. gas rate is increased the reactor pressure is raised to 350# and steam bundles are placed in service as necessary to maintain and equalize reactor bed temperatures.

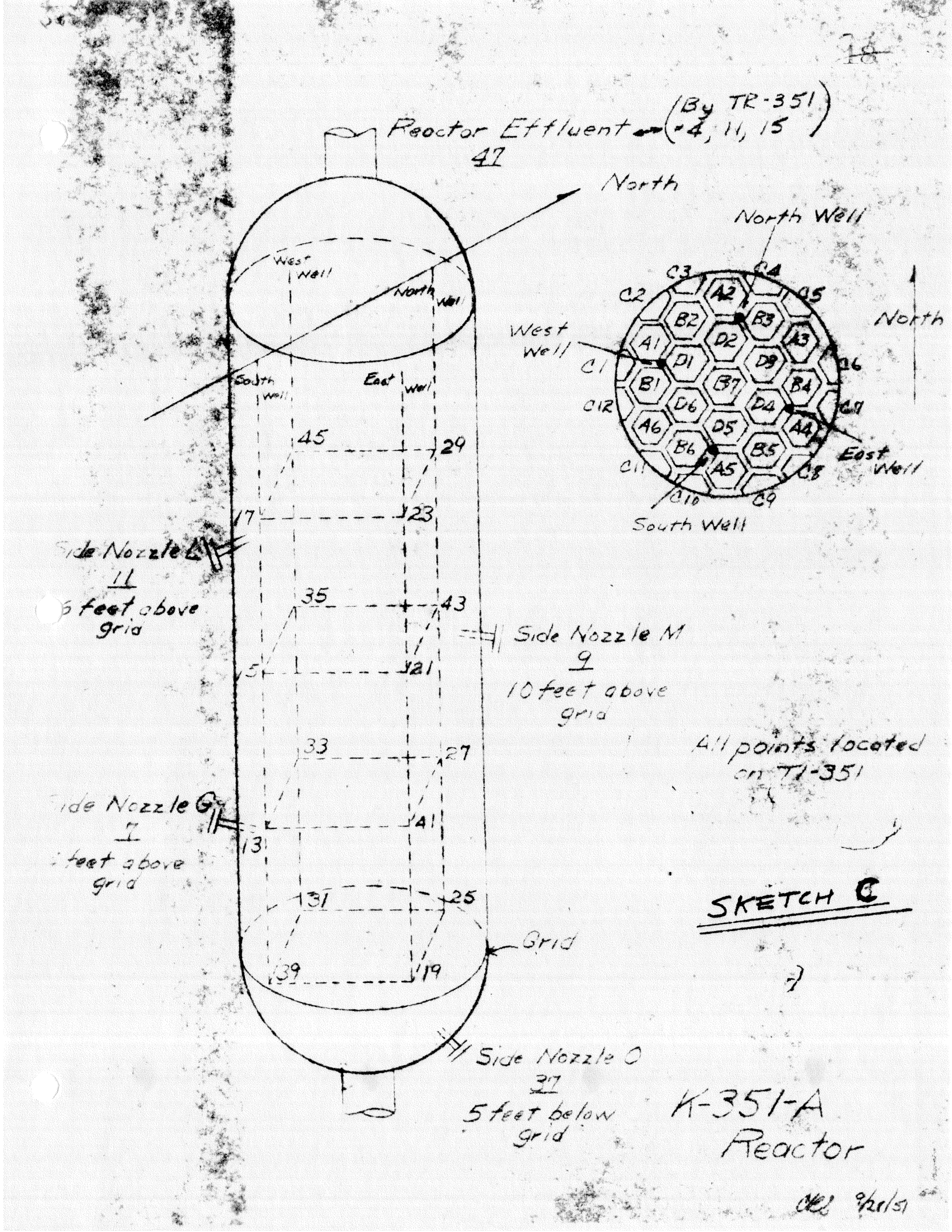
In the earlier runs some of the bundles were left out of service entirely but in recent runs it has been the practice to place them all in service pinching off each bundle circuit as necessary to equalize bed temperatures. No record is kept of the amount of pinching off of the individual steam circuits.

The following Sketch C shows the location of the thermowells in Reactor A with respect to the tube bundles. Those in Reactor B are opposite hand.

Whether carbiding or just starting up directly, acid water is admitted to the gas scrubber as soon as or shortly after synthesis gas is added to the reactor.

The recycle compressor V-351 is started as soon as pressure has been built up on the system.

The plant is always run to load the fresh feed compressor V-302, with fresh feed plus part of the recycle and this entire stream, usually about 4,500,000 SCFH is routed thru the L-305C heater and there preheated to 650°F. The remainder of the recycle is handled by the V-351 compressor and is not preheated. Thus when running with a fresh feed rate of about 3,000,000 SCFH, the


Reactor Effluent
47
(By TR-351
-4, 11, 15)
North
West Well
North Well
East Well
South Well
45
29
17
23
35
43
5
21
33
27
13
41
31
25
39
19
Grid
Side Nozzle L
11
5 feet above grid
Side Nozzle M
9
10 feet above grid
Side Nozzle O
37
5 feet below grid
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
A1
A2
A3
A4
A5
A6
B1
B2
B3
B4
B5
B6
B7
D1
D2
D3
D4
D5
D6
North
All points located on TI-351
SKETCH C
K-351-A
Reactor
9/21/51

output when only one O_2 plant is running, and with a recycle to fresh feed ratio (R/FF) of one, approximately 1,500,000 SCFH of the recycle is preheated along with the fresh feed and an equal amount of the recycle is not. Therefore when the fresh feed rate is increased with the R/FF remaining the same, less of the recycle goes thru the V-302 compressor heater and therefore the combined steam reactor inlet temperature drops. In other words when running with a F.F. rate of 3,000,000 SCFH and R/FF of 1.0, 75% of the total feed to the reactor is preheated to 650°F. resulting in a total feed temperature of about 530°F. whereas when the F.F. rate is increased to 4,500,000 SCFH and the R/FF rate is still maintained at one, then only 50% of the total feed is preheated and the combined feed temperature drops to about 415°F.