ENHANCED V-GRID TRAYS INCREASE COLUMN PERFORMANCE

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Background

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- Ethanol already plays an important role in today's reformulated gasoline
- Fuel Grade Ethanol growth is expected to continue for the next 5 years
- Many new plants will be built and existing plants need debottlenecking.
- Older plants were built with outdated or sometimes archaic technology.

Typical Plant

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- A typical modern plant has 3 main towers; Beer Mash Tower, the Rectifier and Side Stripper
- The Beer Mash tower removes all the solids and most of the water from the fermenters
- The Rectifier takes the overhead from the Beer Mash Tower and concentrates the Ethanol up to the Azeotrope
- The Side Stripper is a Beer Tower without the solids

Typical Flow Scheme

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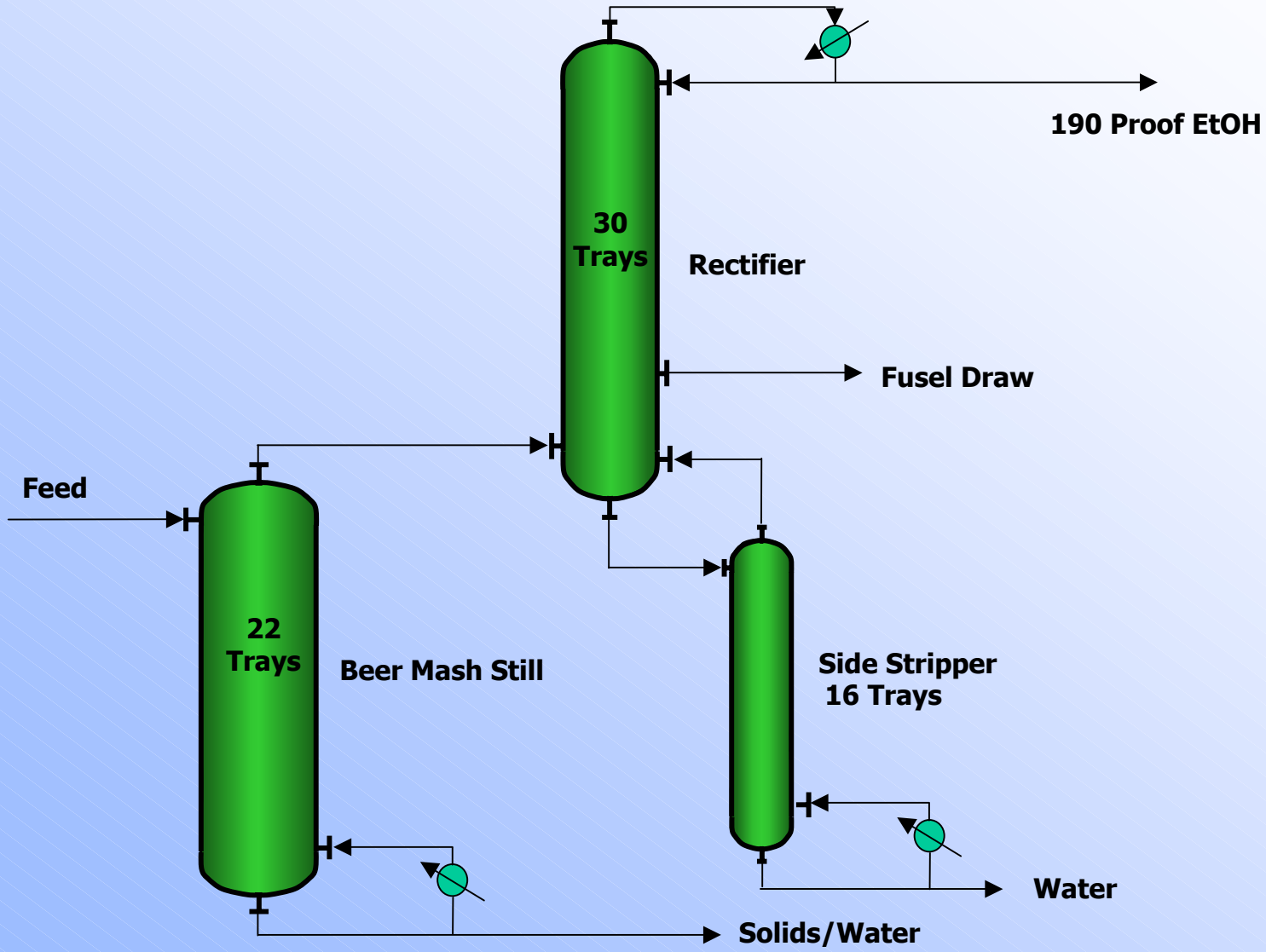

Operation

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- A Beer Mash Tower is a severe fouler
- Feed contains proteins, fibers, sugars, and suspended solids, as much as 14 wgt%
- Ethanol needs to be removed from not only the liquid but from these solids as well
- Any stagnation in these towers results in solids buildup and premature tower flooding

Sight Glasses

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Sump Section

Tray 12

Tray Outlet Area - Old Trays

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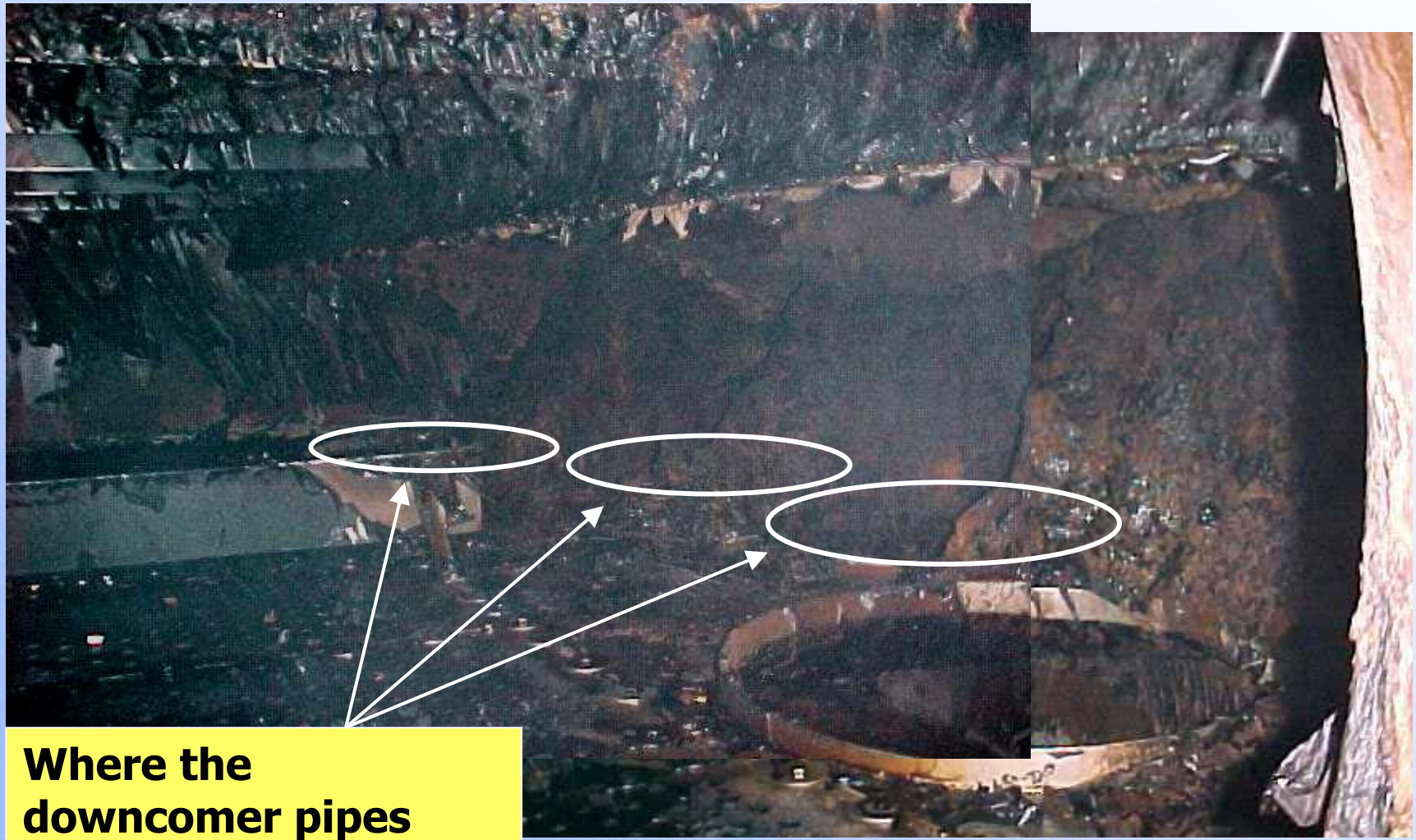

Where the downcomer pipes should be found

The Challenge

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- **AGP's Beer Mash Tower had an extraordinarily high Ethanol content in the bottom at normal production levels**
- **Slight changes in feed rate or feed concentration would dramatically increase the amount of Ethanol in the bottoms**
- **At times Ethanol in the bottom was as high as 0.2 vol %**
- **Typical operating plants see no more than 0.02 vol % Ethanol in the bottom**

Bottoms Purity vs. Feed Rate

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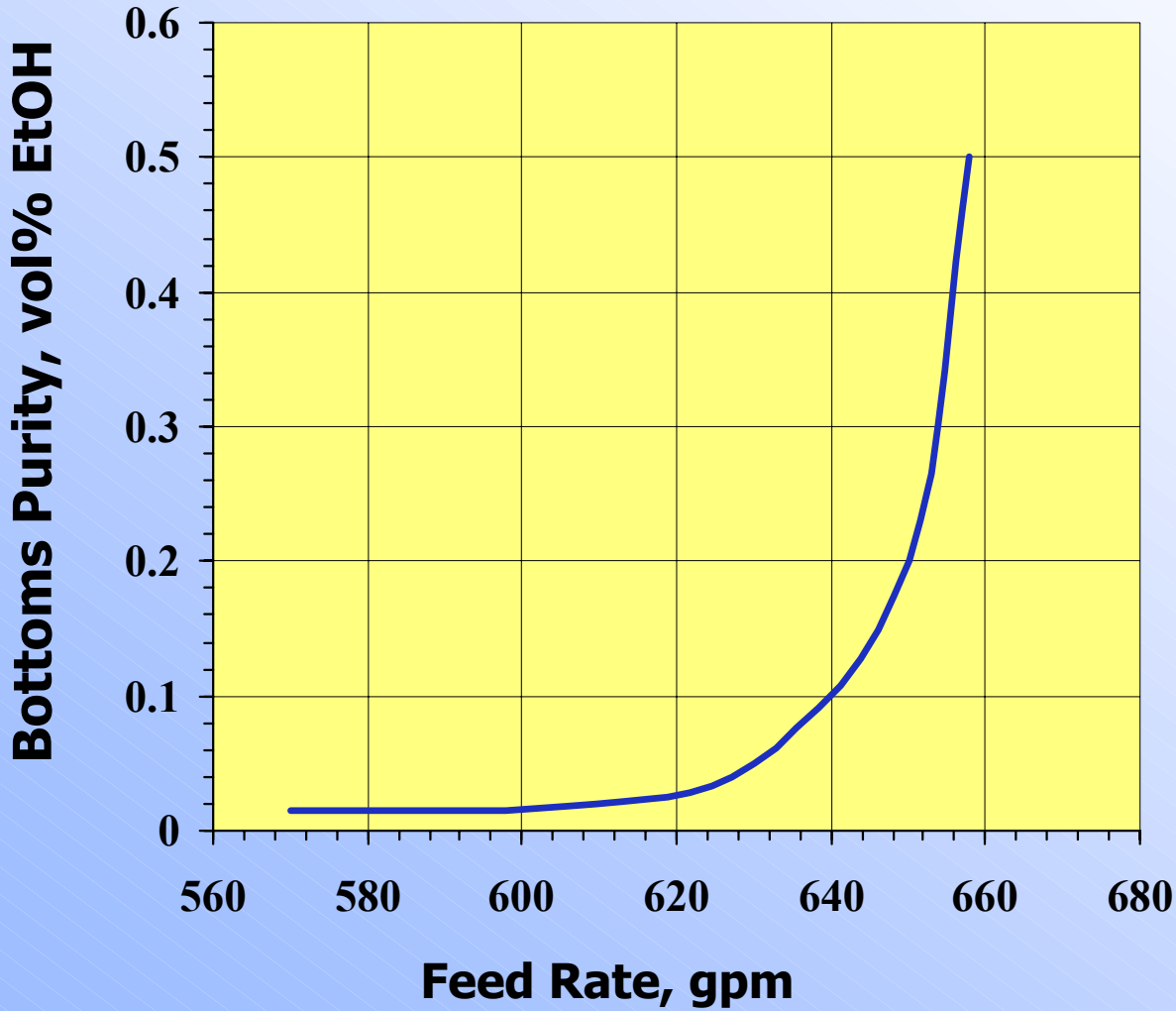

Operating Data Oct. 2, 2001

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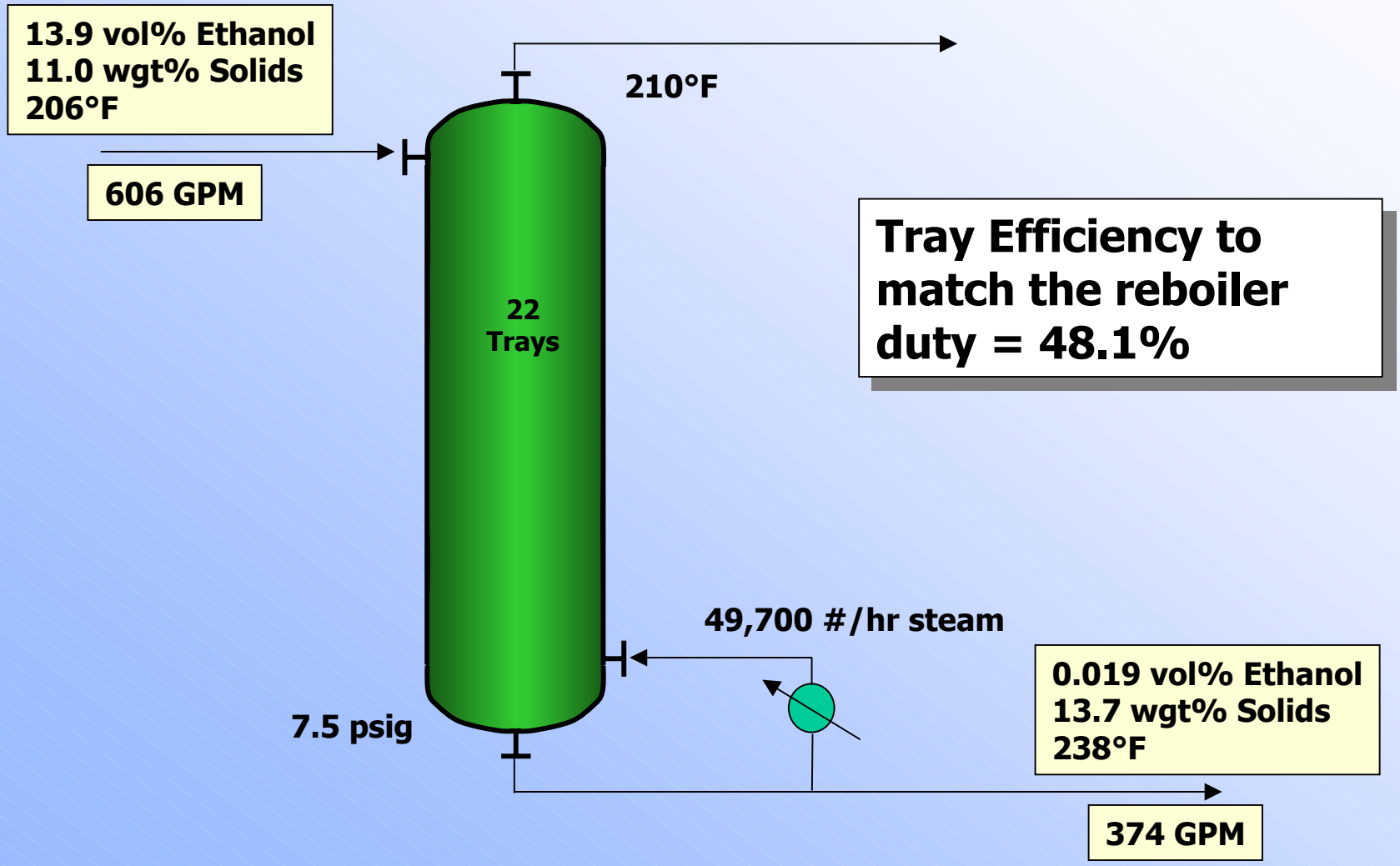

Observations

- **Low observed Tray efficiency and high sensitivity to changes in operation pointed to a need for more theoretical stages**
- **Tray drawings showed that the existing trays had only a 54” flow path length for a 138” diameter tower**
- **Pipe Type Downcomers forced liquid to center of tower**
- **High Efficiency trays that can handle solids were determined to be needed**

Unit Photo

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Options

- Sulzer Chemtech has numerous applications in this particular service, but never had the challenge of significantly increasing tray efficiency

- It was decided that the SVG™ Tray would be used because of its extensive experience in this service. However, an extra enhancement to liquid flow would be added

Testing at Nutter/Sulzer

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- **Over the past several years many different types of flow enhancement devices were tested at Sulzer Chemtech**
- **One of these was the Mini Jet Tab "Push Valve"**
- **These devices could force the liquid on the tray to go in directions it did not naturally wish to flow.**

Testing at Nutter/Sulzer

- **By strategically placing these devices on the tray deck, plug flow of liquid could be achieved and stagnation eliminated.**
- **The device had to be large enough to be effective with large tray openings such as the SVG V-Grid valve**
- **A lot of the credit for distribution of these devices goes to Dr. Mike Lockett who's work in this area in the early 1970's was applied here.**

Mini Jet Tab "Push" Valve

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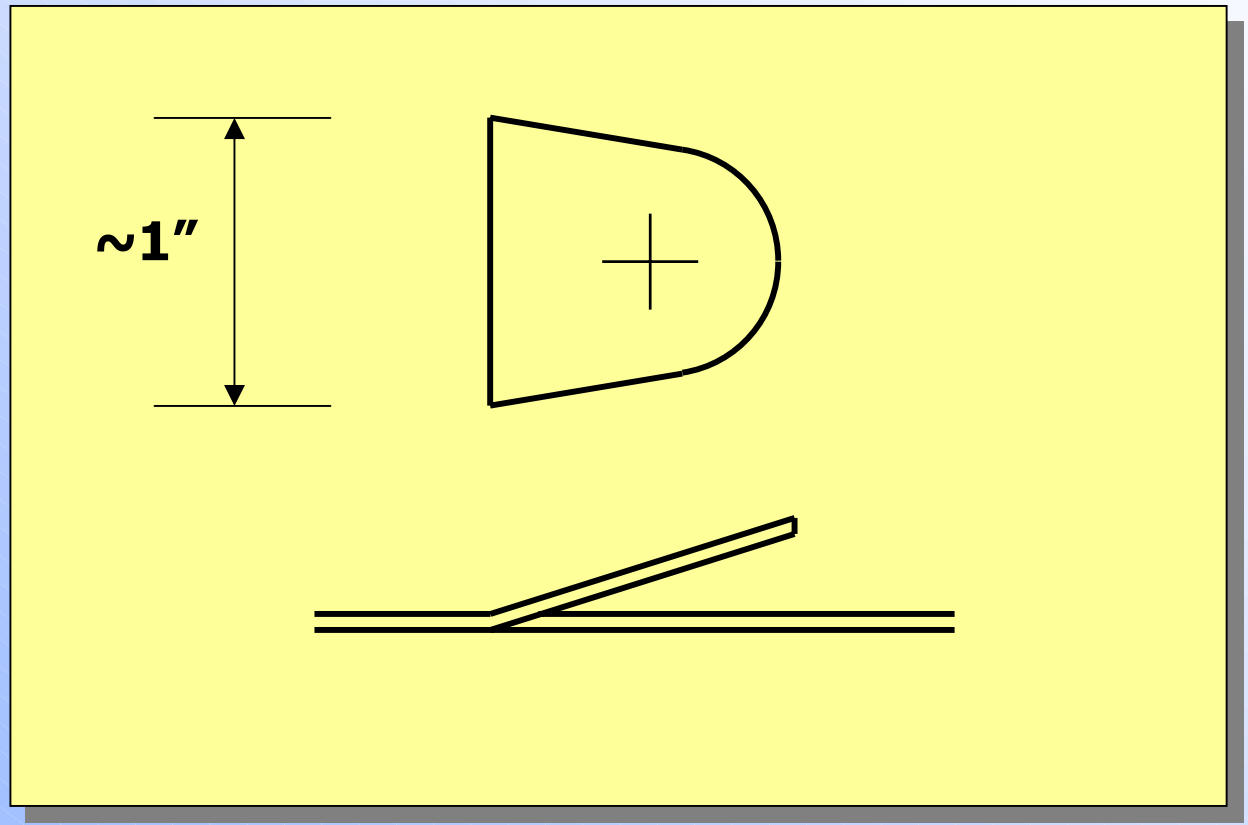

Tray Layout with MJT Valves

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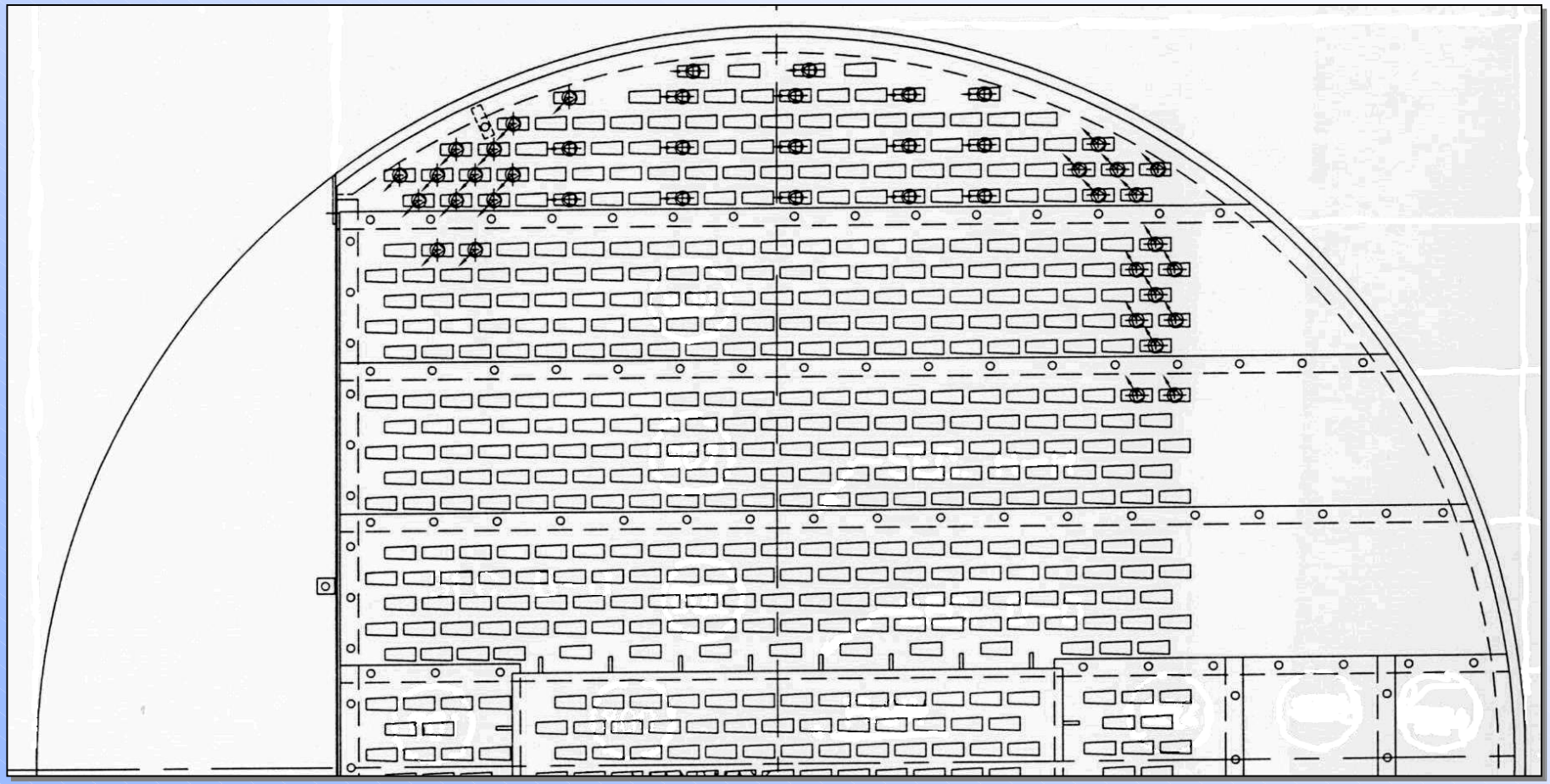
Flow



Tray Layout

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Operating Data Oct. 8, 2002

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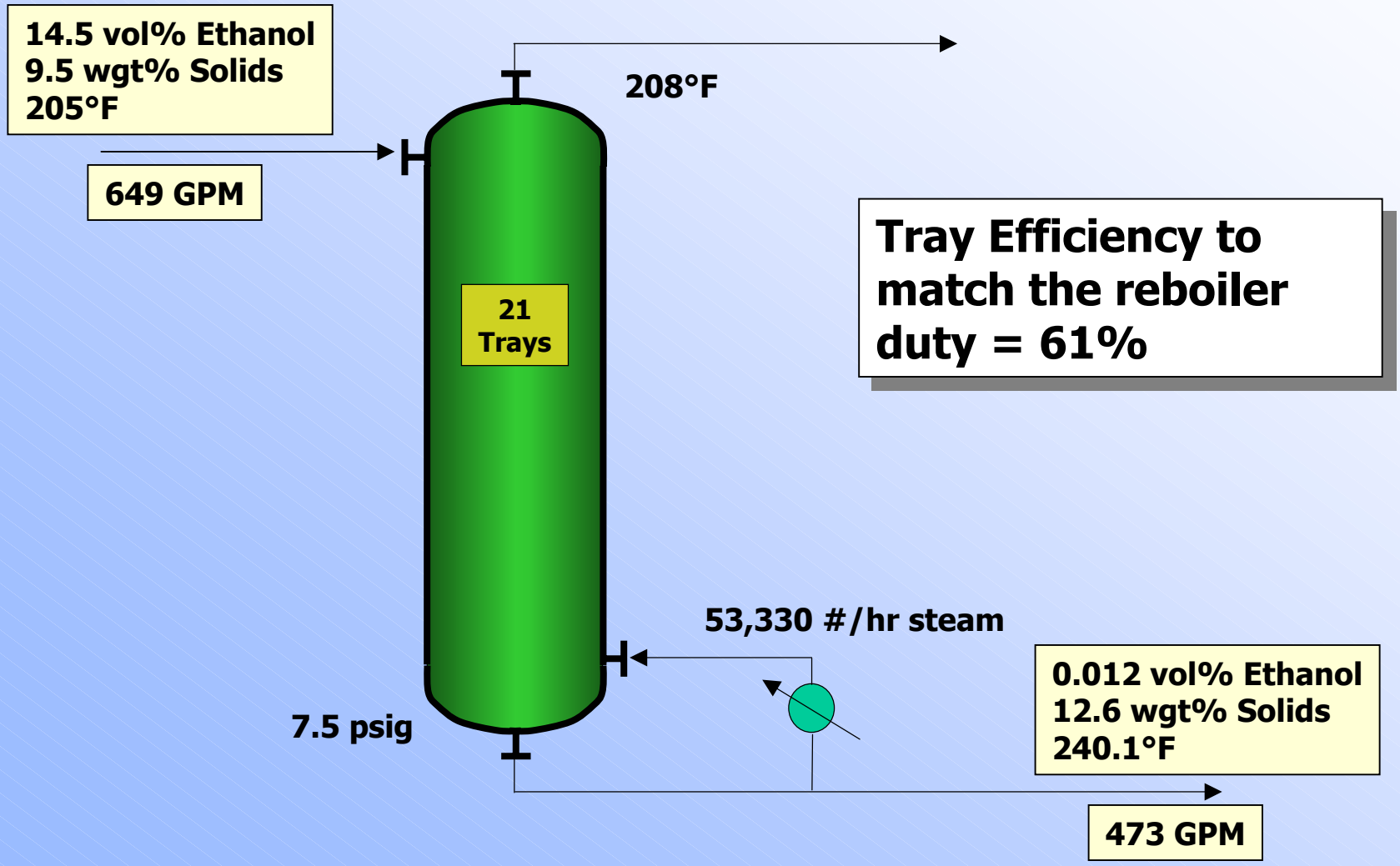

Key Hydraulic Parameters - Not very Loaded

Name:	TOP	BOTTOM
Vapor:		
Jet Flood	**49%**	43%
Dry Tray Pressure Drop, "H2O	0.89	0.71
System Factor	0.6	0.6
Liquid:		
Downcomer Velocity	20%	18%
Weir Loading, gpm/in.	6.25	5.7
Downcomer Froth Backup, %	45%	43%
Tray Pressure Drop, mmHg	5.21	5.04

Conclusions

- **Old ideas can lead to significant progress in new applications.**
- **A 27% increase in tray efficiency was realized through the use of the "push valves" and increased flow path length.**
- **Run length has increased significantly. In the past CIP had to be applied every few months - this tower now has operated since April with no increase in pressure drop.**