
Speaker Introduction
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SOLVING PROBLEMS IN A HIGH STRESS ENVIRONMENT

BY

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PRESENTER'S QUALIFICATIONS

- 37 Years with Exxon Chem in polymers manufacturing and technology.
- 18 years consulting.
- Author of 2 books on problem solving and developer of course utilizing the books.

CURRENT INDUSTRIAL ENVIRONMENT

- Desire for quick answers.
- Complicated processes.
- Experience in technical and operations has decreased.

SYMPTOMS OF DESIRE FOR QUICK ANSWERS

Do you ever hear phrases such as:

- **"Do something even if it is wrong."**
- **"Your lack of urgency is costing us $1M/day."**
- **"No solution – No job."**

PROCESS COMPLEXITY AND INTENSITY HAVE INCREASED

- Reactors are operating at a much higher production/volume.
- Heat input for distillation of close boiling components is designed as a heat pump.
- Reactions are more sensitive to impurities.

REDUCED EXPERIENCE LEVEL

- **Multiple studies indicate that there is a loss of experience that is not being replaced in the developed world.**
- **A similar situation is occurring in the developing world although the cause is different.**
- **This shortage of experience causes intuitive problem solving to be ineffective.**

A NEW PROBLEM SOLVING TECHNIQUE IS REQUIRED

Application of yesterdays techniques based on intuition and experience leads to

- **Chronic unresolved problems.**
- **“The problem went away, but it came back” syndrome.**

THE TOP 10 LIMITATIONS TO PROBLEM SOLVING

1. Modern day processes are large and complex.
2. The problem is almost always more complicated than first described.
3. Conflicting data are always present.
4. Modern day plants have a high degree of variable interaction.

THE TOP 10 LIMITATIONS TO PROBLEM SOLVING (continued)

5. There is a high degree of engineering discipline interaction.
6. System dynamics often involve long residence times.
7. Engineering principles are often inadequately applied.

THE TOP 10 LIMITATIONS TO PROBLEM SOLVING (continued)

8. There is a failure to use a methodical approach.
9. The problem solver often does not see the whole picture.
10. There is often an overdependence on history.

KEY COMPONENTS OF A SUCCESSFUL APPROACH

- **Utilization of a daily monitoring system to discover problems early.**
- **Development of a theoretically correct working hypothesis.**
- **Determination of optimum technical depth.**

DAILY MONITORING SYSTEM

A daily monitoring system must have the following attributes:

- Use a calculated variable that represents the status of the plant.
- Use a variable with theoretical meaning.
- Use a variable that “trigger points” can be assigned to.
- Use trigger points that have some statistical meaning.

DAILY MONITORING EXAMPLE

Reaction kinetics of a polymerization plant are a guideline for the status of the plant. This term fits the definition on the previous slide:

- **It is a calculated variable.**
- **It has theoretical meaning.**
- **Statistical trigger points can be provided.**

CALCULATION OF REACTION KINETICS

$k = CE/(M*T)$

Where:

k = Simplified Reaction Rate Constant

CE = Catalyst Efficiency

M = Monomer Concentration

T = Reactor Residence Time

REACTION RATE VS TIME

WHICH CHANGE IS SIGNIFICANT?

The answer to this question is a function of:

- **A statistical analysis of the data.**
- **An intuitive analysis of the data.**
- **How significant do we need to be.**

HOW SIGNIFICANT DO WE NEED TO BE?

- **Problem solving is not statistical quality control.**
- **Action is almost always required before one is 99+% confident of a problem.**
- **Trigger points become a useful concept.**
- **Automobile maintenance is an excellent example of this concept.**

TRIGGER POINT CONCEPT

Profit Impact	Trigger Point Sigmas	Type 1 Error Probability %
Large	1	30
Moderate	2	5
Small	3	<1

The probability of a type 1 error occurring is the probability that a problem is declared when no problem exists.

EXAMPLE – Tire Pressure Maintenance

A DISCIPLINED STEPWISE APPROACH TO PROBLEM SOLVING

Advantages of approach:

- Avoids "jumping to conclusions".
- Insures that problem is completely understood.
- Targets a theoretically correct hypothesis.
- Provides a paper trail for others to follow.
- Avoids creating secondary problems.

5 STEP APPROACH

1. **Verify that the problem actually occurred.**
2. **Write out an accurate statement of the problem.**
3. **Develop a theoretically correct working hypothesis.**
4. **Provide a mechanism to test the hypothesis.**
5. **Recommend action to solve the problem which does not create a secondary problem.**

FORMULATING THEORETICALLY CORRECT HYPOTHESES

This formulation is characterized by:

- **Rarely being done in meetings.**
- **Requires intense and often lengthy data analysis.**
- **Requires application of engineering principles.**
- **May require literature research or discussion with experts in the field.**
- **A list of questions may be helpful.**

10 HELPFUL QUESTIONS

1. Are all operating directives and procedures being followed?
2. Are all instruments involved correct?
3. Are laboratory tests correct?
4. Were there any errors made in the original or subsequent designs?
5. Have there been any changes in operating conditions or procedures?

10 HELPFUL QUESTIONS (continued)

6. Is fluid leakage occurring?
7. Has there been any usual or unusual mechanical wear?
8. Is the reaction rate as anticipated?
9. Are there adverse reactions occurring?
10. Were there construction errors made in the original plant or in subsequent changes?

EXAMPLE PROBLEM

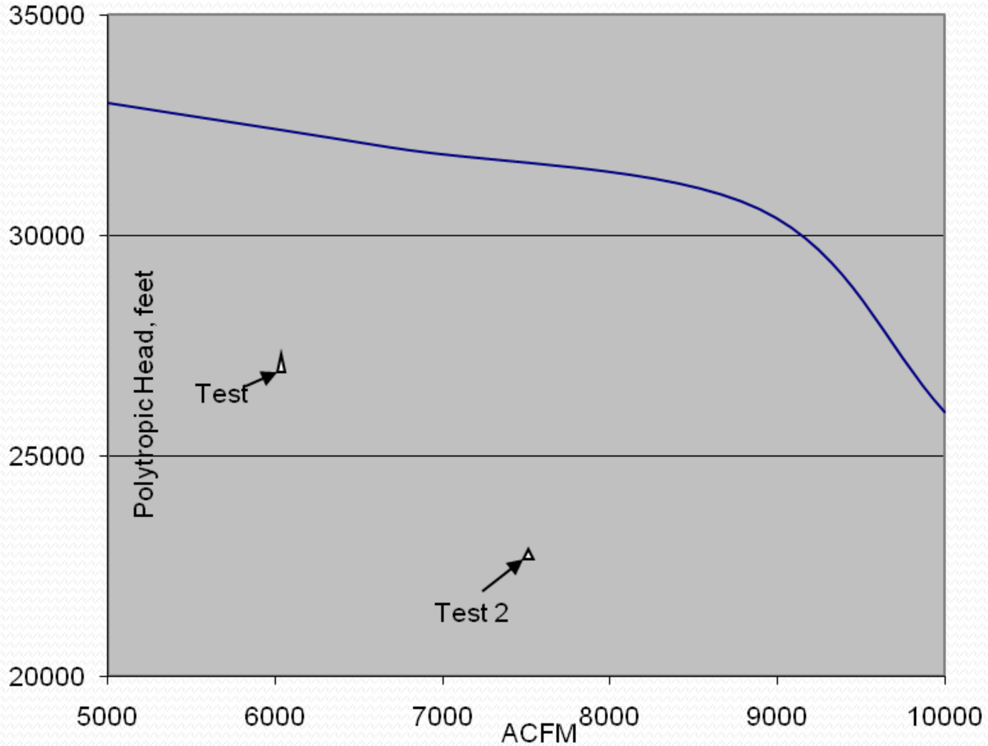


Figure 6-7
Compressor Performance Curve

THEORETICALLY CORRECT HYPOTHESES DEVELOPED

The following hypotheses were developed using the 10 helpful questions.

1. **The suction or discharge piping may be too small.**
2. **The suction or discharge piping may be restricted.**
3. **The steam turbine driving the compressor is slowing down as the compressor HP load increases.**
4. **There may be large amounts of internal recycle. That is the compressor flow from suction to discharge maybe higher than shown on flow meters.**

STEP 4
PROVIDE A MECHANISM TO TEST THE HYPOTHESES

The following action steps were used to test the 4 hypotheses

1. **Pressure drop calculations indicated that the predicted pressure drop was minimal.**
2. **X-rays of the suction and discharge piping were taken and showed a significant buildup of solids in the suction line.**
3. **The speed of the compressor did not change from the design.**

STEP 4 (continued)

The 4th hypothesis could not be eliminated. However it was decided not to pursue this because:

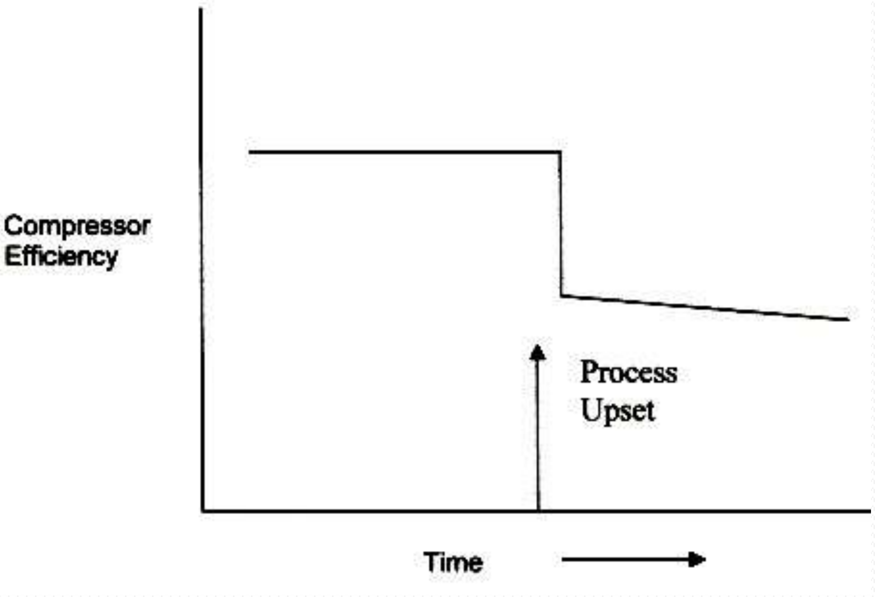
1. **The compressor was new.**
2. **For this hypothesis to be valid the internal recycle would be huge and would result in lower efficiency than measured.**

Based on this analysis, plans were formulated to shut down the compressor and clean out the piping.

STEP 5
RECOMMEND REMEDIAL ACTION

- Remedial action is more than just recommending cleaning the pipes.
- It involves recommendations
  - To prevent the problem from reoccurring.
  - To insure that the solution does not create another problem.
- In this example, it was necessary to determine the source of the solids.

SOURCE OF SOLIDS



SOURCE OF THE SOLIDS

- **There was a process upset that appeared to correlate with the loss of compressor efficiency. It occurred during a period when the drain line from the compressor suction drum was partially restricted.**
- **The true root cause analysis led to the installation of a by-pass valve on the drain line control valve.**

SUMMARY OF TAKE HOME MESSAGES

1. Develop a monitoring system so that you know when the trigger point of a key variable has been reached.
2. Don't short cut the 5 step procedure for problem solving.
3. Make sure that the proposed hypotheses are theoretically correct.

OTHER SOURCES OF INFORMATION

Books by Joe Bonem

- *PROCESS ENGINEERING PROBLEM SOLVING*
- *PROBLEM SOLVING for PROCESS OPERATORS and SPECIALISTS*

Training and Consulting

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Closing Comments

Amanda Robben, VLS Vice Chair

Thank you Joe!

virtuAIChE

- Thank you for speaking tonight
- As our way of saying thanks, we have shipped you a coffee cup