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Messages for Manufacturing Personnel

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Conduct of Operations

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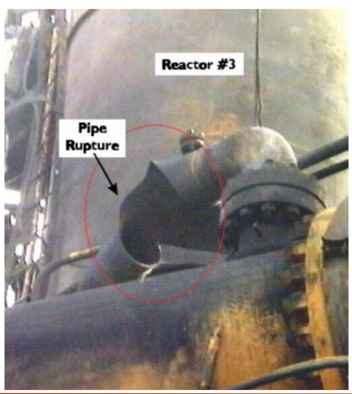
In January 1997 there was an explosion and fire in a hydrocracking unit in a refinery in California. A pipe in the unit ruptured releasing a flammable mixture of hydrocarbons and hydrogen, which ignited resulting in a fire and explosion. There was one fatality and 46 people were injured. One of the causes was excess temperature in one of the hydrocracking reactors. The specified maximum temperature in the reactors was 800ºF (425ºC), and the system was supposed to be shut down if the temperature exceeded this value. The reactor and the pipe which ruptured were believed to have reached a temperature greater than 1400ºF (760ºC).

Previous temperature excursions in excess of the specified 800ºF (425ºC) maximum had occurred, but the system had not been shut down. This led operators to believe that these excursions were acceptable. Also, some of these temperature excursions were not investigated, and recommendations from those that were investigated were not all implemented.



In April 1998 an explosion followed the release of flammable chemicals from a 2000 US gallon batch reactor into a building in a specialty chemical plant in New Jersey. Operators were unable to control the temperature of the batch, and the runaway reaction partially vented through the reactor manway into the production building. 9 people were injured, 2 seriously, and chemicals were released into the surrounding community. It is believed that the initial temperature of the batch was higher than normal, making it more difficult for operators to control the batch temperature with the available cooling.

In 8 of the previous 32 batches produced, operators had difficulty in controlling the batch temperature. The temperature and the rate of temperature rise for individual steps of the process were beyond the limits specified by the procedure. In some cases, the temperature exceeded the maximum range of the reactor temperature recorder (150ºC or 300ºF). In those batches, operators were able to regain control of the batch temperature without a runaway reaction. These temperature excursions were not investigated, and no action was taken in response to them.

What can you do?

Although these two incidents occurred in completely different types of manufacturing plant, they have one important thing in common. In both incidents, the process had exceeded specified safe operating limits during operations before the incident. The abnormal conditions became accepted – this is called “normalization of deviation.” These warning signs were either not investigated, or actions recommended by the investigation were not implemented. “Conduct of Operations” can be summarized in two simple concepts: (1) Say what you intend to do (procedures), and (2) Always do what you say. This means, for example, that if your operating procedures say to shut down if a critical safety parameter exceeds a specified value, you ***must always*** take this action!

- Know what the critical safety process parameters are for your plant, know the consequences of exceeding them, and know what to do if they are exceeded.
- Always take the required actions if critical safety parameters are violated.
- If critical safety parameters are exceeded, report it to management so an appropriate investigation can be done.

What are your plant’s critical safety control limits?

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Questions:

1. **(5 min)** What two errors led to the 1997 hydrocracking unit explosion? Describe how the errors could have been corrected to prevent or mitigate the incident.

2. **(5-10 min)** For the 1998 batch reactor explosion, what went wrong and how could it have been prevented? Consider whether operators had a false sense of safety with regard to large temperature variations.

3. *****(20-30 min)** Whenever reactor temperatures are exceeded, significant temperature variation is observed, or reactor temperature cannot be properly controlled, what should be done to the system from a design or maintenance standpoint? What kinds of things would you check? *Hint:* You may find helpful the safety recommendations outlined in the *Measures* section of this article.

4. **(5 min)** *What did you learn?*
   What lessons have you learned from this article and how can you apply them to your chemical engineering career?