Availability Estimations for Utilities in the Process Industry

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I. Introduction

An important performance measure of a plant is the plant-availability. The higher availability the better, since a high availability implies a possibility for a large production volume and thereby an increased profit for the company. One way of increasing the plant-availability is by eliminating, or minimizing the effect of disturbances. The cause of a disturbance can be personnel, material or equipment, where material includes both raw materials and utilities.

The aim of this work is to increase the plant-availability by decreasing the effects of plant-wide disturbances caused by utilities. The first step is to determine the set of utilities that can be present at an industrial site, what disturbances these utilities can suffer, and how frequent and safety-critical these disturbances are. A later step will be to determine the effects on the plant-availability, and ways to decrease or eliminate these effects.

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II. Utilities

Utilities, in opposite to raw materials, are materials that are used plant-wide and are crucial for plant operation but are not part of the final product. Common utilities are

- **Steam**: The steam net is commonly used to supply energy for distillation. Other uses are to supply energy for endothermic reactions and to heat a reactor at start-up. There could be several steam nets at the same site, for example one net with high pressure steam and one with low pressure steam.
- **Cooling water**: The cooling water system is used for cooling at exothermic reactions and in the condensing phase of distillation.
- **Electricity**: Electricity is needed in order for the instruments, e.g. pumps, to operate.
- **Water treatment**: A Water treatment utility is used for purification of process water, precipitation and ground water.
- **Combustion of tail gas**: A system for combustion of tail gas, such as a flare, is a safety device needed at unforeseen events.
- **Nitrogen**: Nitrogen is needed to maintain pressure in vessels.
- **Feed water**: Feed water is used in boilers to produce steam.
- **Instrument air**: Instrument air is needed for the pneumatic instruments to work.
- **Vacuum system**: Vacuum is used to lower the boiling point of a liquid to facilitate distillation and to remove gas produced in reactions.

A flowchart can be made for each of the utilities, showing how the utility flows through the areas of the production site. An example is showed in Figure 1.

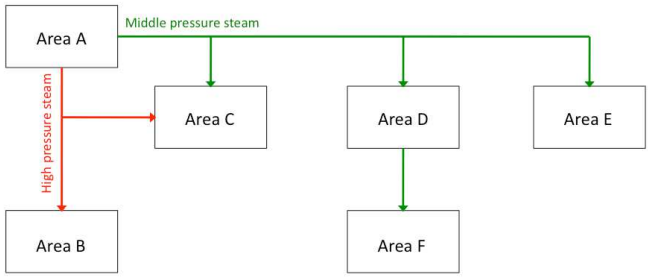

Fig. 1. Example of a utility flowchart for steam. The site contains 6 areas, A-F, and has two steam nets producing high and low pressure steam respectively.

A utility could suffer from different disturbances. For example, a steam net could suffer disturbances such as too high or too low steam pressure. One way of defining when a disturbance on a utility occurs is to set limits, such that if the parameter goes outside this limits, the disturbance will have economical or safety consequences.

III. Availability

The availability of a production unit is according to ISO22400, draft 1, the fraction of the main usage time, which is the producing time of the unit, and the planned busy time, which is the time that the production unit is used for the execution of a manufacturing order. The availability of a utility can be estimated by taking the fraction of time when the utility does not suffer a disturbance over the total time. If measurements are available of the key parameters that define the disturbance, the availability can be computed directly from historical data.

IV. Future Work

When availabilities for the different utilities have been computed, the consequences of each disturbance must be evaluated. When both frequency and severity of all disturbances on utilities are known, focus on handling the disturbance with highest severity$\times$frequency-factor to improve availability of the entire production plant as much as possible.