A Shortcut to Sizing Liquid-Add N_2 Generators

Nitrogen gas requirements frequently experience significant changes in demand over time. Selecting the proper size of an on-site generator is important to achieve an optimal cost structure. Generally the base load is assigned to a generator and the peak loads to imported liquid nitrogen. The cost of the on-site generated gas is a fraction of the imported liquid, so proper size selection is critical.

Most small liquid-add nitrogen generators do not turn down efficiently, so the power at partial load is nearly the same as full load. Therefore, oversized units waste power when the demand is less than the design flow. On the other hand, the imported liquid is substantially more expensive than the generated gas. Running the generator at partial load may still be cheaper than using liquid for a short period. The following is a "quick" method for proper size selection.

Step 1

- **Determine a characteristic period for load profiles. (This may be weekly, monthly, or other.)**
- **Select a measuring "interval" (minutes, hours, shifts, etc).**
- **Obtain data on average flows for each interval over the period.**

Example: See Figure 1 – Here the period is weekly, the interval is hourly, and the flow is in Nm^3/hr.

Step 2

- **Rearrange the intervals in descending order of flow. Hint: using a spread sheet program makes this task easy.**

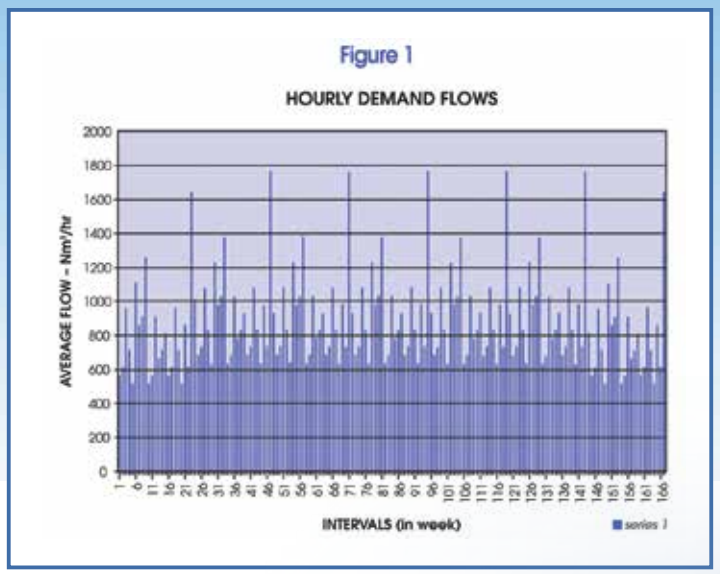
Step 3

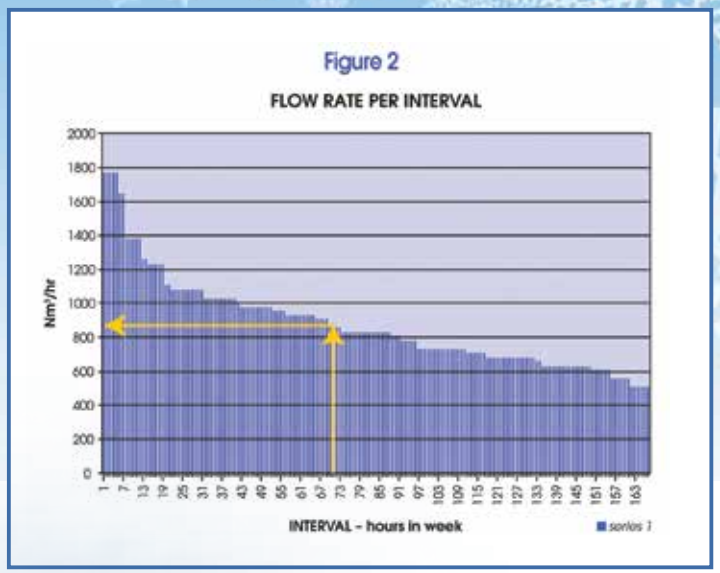
Determine the Incremental Cost of Gas Generated. This is normally derived from the cost of power for an incremental volume of gas produced in the generator plus the incremental cost of capital related to a larger generator. The extra liquid added is small and can be neglected.

Divide the Incremental Cost of Gas Generated by the cost of imported liquid delivered to the site to get the Cost Ratio (CR). In our example assume power at $0.05/kw-hr, the Specific Power at 0.28 kw-hr/Nm^3 and the incremental capital is $0.015/$Nm^3$/hr. The cost of imported liquid delivered to site is $0.069/$Nm^3$ The CR calculates to be 0.42.

Step 4

Multiply the number of Intervals by the CR (0.42 * 168 = 71) and plot on the the chart as developed in Step 2. Size the gas generator (in the example 860 Nm^3/hr). This is the optimum point. A larger generator than this would be more costly. The number of intervals able to use the gas are too few to justify the added capacity.





The above example demonstrates a quick method for size selection and is useful for estimating the choice. A number of other factors such as model (frame), breaks in hardware, relative availability of the imported liquid in the area, or long term changes in demand should also be considered when making the final size selection.

This exercise is also useful as a quick method to determine the size selection. For instance, try changing the power cost to see if the plant selection alters significantly.

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