Process Systems Cost Factors Guide

Factors That Raise the Cost of a Process System

Listed below are a few of the factors that have a major effect on the cost of a process system. When you seek out pricing from process design and build firms, these are the areas to examine and discuss.

The explanations below gloss over some of the finer details that complicate things, but they are a good jumping off point for understanding cost drivers and process design trade-offs. An experienced design build firm should be able to help you thoroughly understand where adjustments can be made to reach your budget and process design goals.

Process System Cost Factors:

1. **Application complexity** – a more complex process has more equipment requirements, engineering design and modeling, and more complicated programming. Each of these drives up cost but may be required to make the process system work properly. However, some applications can be simplified or unit operations can possibly be removed depending on what you are trying to do. This is an area that can be discussed with your process designer.

2. **Process Conditions** – High temperatures and high pressures also drive price up. The more difficult or unusual the process conditions, the higher cost will be. Examples of situations that will drive up temperature and pressure costs include high viscosity fluids, particulates/slurries, non-Newtonian fluids, and degree of difficulty of separation (if required). Operating under a vacuum, for example, can sometimes lower required temperature inputs, but is not always appropriate. Narrowing critical ranges, splitting up certain operations, or changing selected unit operations can also sometimes help in this area.
3. **Flammables** –Flammability changes relief sizing and electrical classification which, in turn, effects instrumentation and materials of construction costs. Depending on your industry, various safety standards will need to be met with flammables as well.
4. **Instrumentation** – Depending on what you are doing with your process system - i.e. is it an experimental pilot plant or a permanent production skid? – Varying levels of instrumentation may be needed. Instrumentation costs can rival (or surpass) other equipment costs so knowing what parameters are critical is vital. Additional instrumentation also requires more engineering time to specify and program. By examining need to know vs. nice to know data, you may be able to eliminate some unnecessary instrumentation.
5. **Flow Rate** – Overall throughput of the unit also drives cost. The higher the flow rate, the larger the required piping, vessels and instrumentation sizes. Larger piping and instrumentation cost more. A 4-inch diameter pipe is dramatically more expensive than ½ inch. Scaling back or splitting production requirements might be a way to lower flow rates.
6. **Number of Pieces of Equipment** – More equipment means higher costs. This is one is pretty intuitive. More equipment means more money spent on purchasing equipment, and more engineering time specifying equipment and design layouts. The final amount of required equipment will depend on tradeoff decisions made when considering other factors and final system design, so keep this in mind as you work through this with your design team.

7. **Major Equipment Types** – Some pieces of equipment are relatively expensive and can end up driving a sizeable portion of the overall cost. For example, specialty items that have very few manufacturers, compressors, mills, and other large rotating equipment are almost all expensive.
8. **Materials of Construction** – Will this system be built out of mild carbon steel or does the whole system need to be glass with lined pipe? Certain chemicals and processes will require more expensive materials of construction to remain safe and contaminant free. Materials of construction have a large effect on piping, vessel, and instrumentation cost. There are some basic rules of thumb for the price difference here your fabrication firm can walk you through.
9. **Available Utilities** – Depending on what utilities are already on site, you may be able to use cheaper, alternative equipment, and/or choose not have to have skid-mounted utilities. If no (or few) utilities exist, these will need to be built into the process skid or added on-site.
10. **Site Readiness** – Is there an existing concrete pad with electrical hookups and utilities? If not, concrete and civil work should be taken into account. One way to reduce civil site costs is to use a modular process design where your system is designed as self-contained unit that can often fit into small existing spaces.
11. **Project Management** – It's easy to forget cost associated with project management when you are totaling your other expenses, but it is probably the most vital money spent on any project. The project manager's job is to ensure that everyone else has everything they need to keep things moving forward and that the schedule and budget stay on track. We would NOT recommend going as cheap as possible here; you are looking at a net expense effect. A really good project management firm might be more expensive per hour, but if they can keep everyone on track, avoid common overage issues, and deliver in less hours, it's a lower overall total cost.
12. **Craft Labor** – Setting the equipment, bolting the piping together, wiring the instrumentation and the thousand other tasks required for any construction project are easy to underestimate and are almost as expensive as the equipment itself. Again, think twice before going to cheap here. Bad system fabrication and assembly leads to more costs and shorter system life in the long run. Vet vendors for experience, quality, and lasting return on investment in this area.

13. **Procurement** – Specifying every detail of a vessel, (ex. nozzle orientation, nozzle sizing, piping hookups, pump requirements, etc.,) is a detailed and difficult process. Procurement can be a critical timeline factor. If done wrong, equipment won't be available when you need it due to long lead times, and the project will quickly fall behind schedule. Also, specific brands and vendor alliances can help or hurt overall costs, depending on what they are. Some designers get bulk pricing by having vendor alliances, but that means less flexibility in supplier sources which can limit your selection. If your plant already uses certain brands and it's easier for the maintenance or engineering department to stick with those brands, look for suppliers that are flexible and can accommodate your requirements.
14. **Operating Costs** - Operating costs include everything needed to run the plant on location. Raw materials, electricity, water and man-power are all examples of typical operating costs. While your design build firm does not have any direct control over lowering the operating costs of a particular system while onsite, the way the system is designed can affect those long-term operating costs. For example, changing the required amounts of water or nitrogen, or designing parts of the system to run on gas vs. electric. You should be evaluating proposed designs for operating costs and discussing changes that can be made with your process system design team if operating costs are projected to be high.

Putting together an accurate cost estimate for a process system is non-trivial but getting a rough order of magnitude estimate can help to see if this project is in the ballpark of what is reasonable. Some firms may require payment to do a Rough Order Magnitude Quote (ROM) or front-end engineering design work to determine accurate costing. The cost of that work should land around 1-5% of the overall total cost of the process system project and is well worth eliminating unknowns and getting accurate pricing with no surprise costs later down the road.

Cost Tradeoffs to Consider

When evaluating quotes or cost estimates, there are tradeoffs you can evaluate that could reduce the costs of your process system depending on the specific application. These are good tradeoffs to discuss with your design and build firm during the ROM or Front-end engineering stage of a project, because they could have a major effect on project design and overall cost.

Work with your project partners to consider if you can:

1. **Shift any capital costs to operating costs?** Depending on how budgeting and expenses work at your company, you might be able to get a process system initial price down by moving costs to operational costs. This can mean fewer automatic valves or removing automated solids handling equipment in lieu of an operator with a shovel. Just be careful not to sacrifice the robustness of your overall system. People can be inconsistent and could potentially introduce a new source of process upsets, increase transient states, or require startups & shutdowns.
2. **Reduce Materials of Construction (MOC) costs?** Reducing MOC costs is another way to bring down your overall expenditure. You might be able to get away with something that just has a 'good' or 'fair' rating depending on the particulars of your process. Obviously, the best way to confidently make this call is coupon testing at lab scale. Also, don't forget to consider operational lifespans when thinking about this. A lesser rated material might not last as long.
3. **Can you change your throughput requirements?** Good engineering judgement and cost benefit analysis are critical when making this choice. Knowing which unit operations are most likely to change with scale and how to combat this is key – this is where a professional can help.
4. **Is there a more suitable site?** If you can locate your process system on a site with existing utilities it is almost always an excellent call. It is doubly so if required draw materials already exist for your process. One word of caution here; remember to check your air & water permits, especially if your process might alter an existing permit.
5. **Does all your instrumentation serve a specific purpose?** Identify what instrumentation matters and trim back as much as possible. If the data gathered won't change any design decisions or

refine any selections, it might not be worth the cost to gather it. Knowing which measurements are critical and which fall into the 'just nice to know' category is imperative.

6. **Does your project fit with a compressed modular build schedule?** Modular fabrication can reduce cost through off-site construction at a process system fabrication plant, which helps compress project timeline, ensure quality production-like construction inside a controlled environment, and reduce OSHA exposure hours. Read more about advantages to modular fabrication here.

This is certainly not an exhaustive or fool proof list to make a process system more affordable, but ideas to get you started. Take this advice and combine it with good engineering sense about your own technology, expertise from a process system designer, and common sense.

By: Stephen Benbrook

Process System Engineer

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