Project Documentation

The project documentation will include

1. General correspondence within the design group and with
   - Government departments
   - Equipment vendors
   - Site personnel
   - Client
2. Calculation sheets
   - Design calculations
   - Cost estimates
   - Material and energy balances
3. Drawings
   - Flowsheets
   - Piping and instrumentation diagrams
   - Layout diagrams
   - Plot/site plans
   - Equipment details
   - Piping diagrams (isometrics)

- Architectural drawings
- Design sketches

4. Specification sheets
    - The design basis
    - Feed and product specifications
    - An equipment list
    - Sheets for equipment, such as heat exchangers, pumps, heaters, etc.
5. Health, Safety and Environmental information:
    - Materials safety data sheets (MSDS forms)
    - HAZOP or HAZAN documentation
    - Emissions assessments and permits
6. Purchase orders
    - Quotations
    - Invoices

Codes and Standards

The need for standardization arose early in the evolution of the modern engineering industry.

The terms standard and code are used interchangeably, though code should really be reserved for a code of practice covering, say, a recommended design or operating procedure; and standard for preferred sizes, compositions, etc.

All of the developed countries and many of the developing countries have national standards organizations, which are responsible for the issue and maintenance of standards for the manufacturing industries and for the protection of consumers.

The principal ones of interest to chemical engineers are those issued by

American National Standards Institute (ANSI),

American Petroleum Institute (API),

American Society for Testing Materials (ASTM),

American Society of Mechanical Engineers (ASME) (pressure vessels and pipes),

National Fire Protection Association (NFPA; safety),

Instrumentation, Systems and Automation Society (ISA; process control).

International Organization for Standardization (ISO) coordinates the publication of international standards.

Large design organizations will have their own (in-house) standards.

Engineering design work is monotonous and repetitive, and it saves time and money, if standard designs are used whenever practicable.

Equipment manufacturers also produces standardized designs and size ranges for commonly used items, such as electric motors, pumps, heat exchangers, pipes, and pipe fittings.

If designer use the standardized component size then it is easy for him/her to integrate piece of equipment into the of the plant.

However, there is some disadvantages of standards. Standards impose constraints on the designer.

For Example:

The nearest standard size will normally be selected on completing a design calculation (rounding up), but this will not necessarily be the optimum size.

Standard size will be cheaper than a special size, it will usually be the best choice from the point of view of initial capital cost.

Design Factors (Design Margins)

Design is an inexact art; errors and uncertainties arise from uncertainties in the design data available and in the approximations necessary in design calculations.

Experienced designers include a degree of over-design known as a “design factor,” “design margin,” or “safety factor,” to ensure that the design that is built meets product specifications and operates safely.

Design factors are also applied in process design to give some tolerance in the design.

For example:

The process stream average flows calculated from material balances are usually increased by a factor, typically 10%, to give some flexibility in process operation. This factor will set the maximum flows for equipment, instrumentation, and piping design.

Optimization

Optimization is an intrinsic part of design: the designer seeks the best, or optimum, solution to a problem.

Many design decisions can be made without formally setting up and solving a mathematical optimization problem.

The design engineer will often rely on a combination of experience and judgment, and in some cases the best design will be immediately clear.

Other design decisions have such a trivial impact on process costs that it makes more sense to make a close guess at the answer than to properly set up and solve the optimization problem.

Chemical engineers working in industry use optimization methods for process operations far more than they do for design.

These methods are used in almost every industry for planning, scheduling, and supply-chain management: all critical operations for plant operation and management.

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Typical design optimization objective

Maximize	Minimize
Project net present value	Project expense
Return on investment	Cost of production
Reactor productivity per unit volume	Total annualized cost
Plant availability (time on stream)	Plant inventory (for safety reasons)
Process yield of main product	Formation of waste products

Constraints and Degrees of Freedom

The constraints on the optimization are the set of equations that bound the decision variables and relate them to each other.

For example: Optimize (Max: or Min:) $z = f(x)$

subject to (s:t:): $g(x) \leq 0$

$h(x) = 0$

If the problem has n variables and m_e equality constraints, then it has $n - m_e$ degrees of freedom.

If $m_e > n$, overspecified

$m_e < n$ the number of parameters that can be independently adjusted to find the optimum.

When inequality constraints are introduced into the problem, first convert the inequality constraint into an equality constraint which reduces the number of degrees of freedom by one and makes the problem simpler.