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CHEMICAL BULLETIN NO. 51

SUBJECT: EVALUATION OF CONSTRUCTION MATERIALS

SUMMARY:

How to evaluate the economy of construction materials is a problem faced at some time by practically all engineers and purchasing agents in the chemical process industry. Here is a system advocated in "Chemical Engineering" (January, 1953) that should be of interest, especially to users of lead equipment.

It is shown that in many applications lead pipe can be the most economical material to use despite a higher nominal corrosion rate and higher initial cost. In the case cited, lead pipe proved to be actually far less expensive for equivalent service than Duriron, mild steel, monel or even cast iron.

HOW TO USE CORROSION DATA:

Design engineers often do not realize the tremendous importance of corrosion data in their design work. For example, an engineer may be asked to determine the most economical piping material for handling 60 percent H_2SO_4 at 200° F. By consulting the literature he can usually find corrosion data for such a case, such as listed in the table on page 3.

Offhand, many design engineers faced with such a tabulation would be inclined to select the material with the lowest corrosion rate, usually expressed in inches penetration per year (ipy) and would probably rate them in increasing order of corrosion rate. In this case Duriron would be first and cast iron last. But this does not necessarily give the most economical installation.

Assuming that contamination of the product by the construction material is not a problem then the proper procedure is to determine the material which will give the lowest cost per year, not necessarily the lowest corrosion rate.

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To do this we first compute the life expectancy for each material in the table and from that (plus installation cost information) determine the actual cost per year for each material. To start off we make the following assumptions:

1. Since we are dealing with piping material we will assume that 100 feet of pipe with 4 fittings and 2 valves will be used.

2. We will assume that the useful service life of the pipe ends when half of the original wall thickness has been corroded away.

HOW TO CALCULATE ACTUAL ANNUAL COST:

With the above assumptions we proceed by four steps:

1. From the pipe size and schedule number* determine the wall thickness of each material to be used.

2. Compute the life expectancy in years by dividing half the wall thickness in inches by the expected ipy.

3. If possible, secure actual data on the labor and material cost for each construction material under consideration.**

4. From the total cost and life expectancy calculate the yearly cost of each piping string by dividing the cost by the life expectancy.

Following through these four steps for each construction material produces the table given here. The most economical material; that is, the one with the lowest cost per year, turns out to be chemical lead which rated second in corrosion rating. Note that the order of increasing cost is quite different from the order of increasing corrosion rate.

* Schedule numbers are given in A.S.A. Standard B36.10 and refer to pipe wall thickness.

** If such data are not readily available use that of R. A. Dixon on pipe cost estimation ("Chemical Engineering," pp. 123-135, January, 1950). Dixon's report gives labor and materials cost for most kinds of piping materials but is based on July, 1941 costs. To allow for present day inflationary values it is necessary to "factor" his data up to the present by the use of a suitable index such as the Marshall and Stevens Indexes published monthly and revised quarterly in "Chemical Engineering." The data used here were taken from Dixon's figures.

Economic Comparison of Piping
For Handling 60% H_2SO_4, 200° F

Material	Inches per Year*	Wall Thickness, 2-In. Pipe, Inches	Life Expectancy, Years	Total Cost, $	Cost per Year, $
Chemical Lead	0.008	.1875	11.7	613	53
Duriron	0.006	0.154 (Sch. 40)	12.8	991	78
Mild Steel	0.270	0.218 (Sch. 80)	0.4	277	693
Monel Metal	0.046	0.154 (Sch. 40)	1.7	1,184	697
Cast Iron	0.890	0.218 (Sch. 80)	0.1	126	1,260

* Data from Tech. Bull. T-3, Oct. 1948, p. 32, International Nickel Co.

This same method can be applied to any corrosive environment and to most other types of corrosion resistant equipment, thus enabling the design engineer to select the most economical material for any particular service.