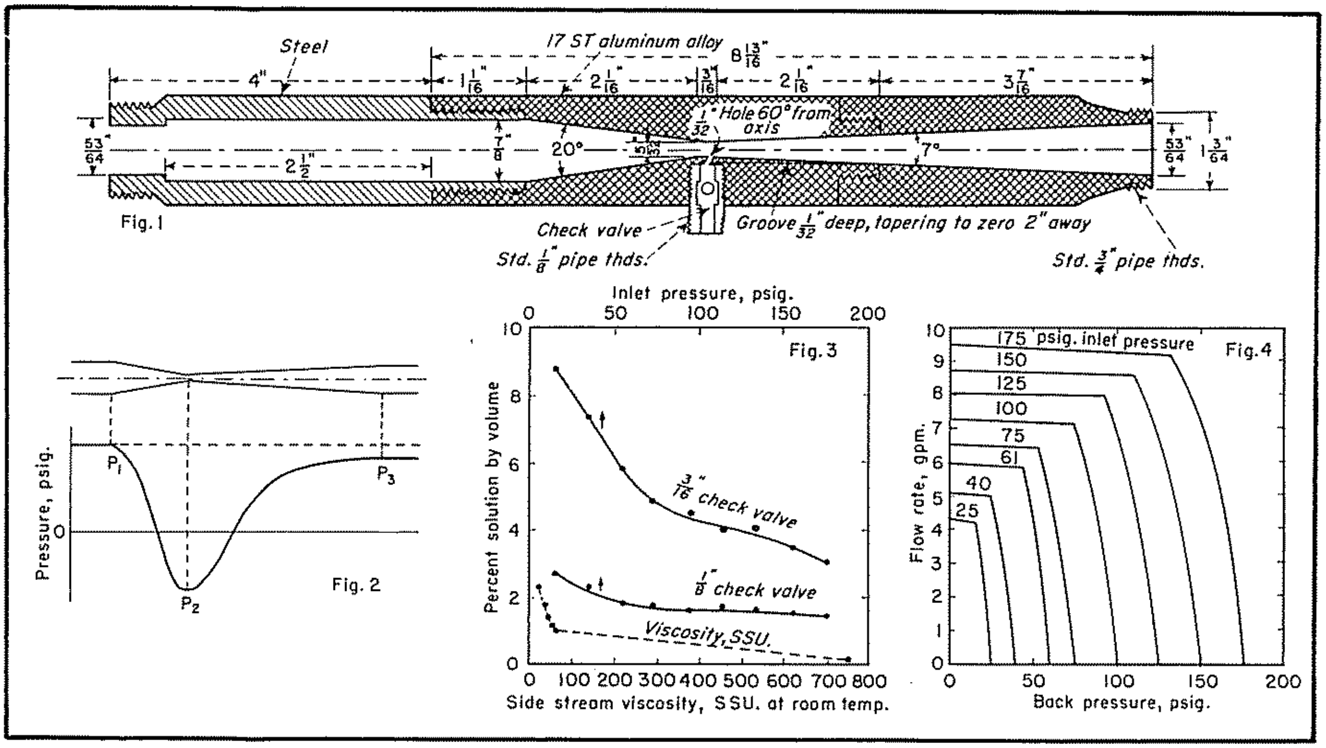
The Plant Notebook Edited by Theodore R. Olive



How to Build a Venturi for Proportioning Service

P. L. Walker, Jr., *and* R. J. Foresti, Jr., *Instructor and Research Fellow, respectively, Division of Fuel Technology, Pennsylvania State College, State College, Pa.*

★ **September Contest Prize Winner**

To an increasing extent mixing operations are being handled on a continuous flow basis, which means that some form of proportioning device must be used. Commonly a pump will be used for this purpose, but in cases where power for the pump may not be readily available, another device such as a venturi may be preferable. A venturi derives the energy needed to draw in the second liquid (side stream), from the flow of the main liquid stream.

Venturis are commonly used as primary flow measuring devices where their small permanent pressure drop is an advantage. It has also been known for many years that if a hole is drilled into the throat at right angles to the flow, a strong suction can be produced (P_2 in Fig. 2) which permits the venturi to be used as a proportioner. Thus the idea of proportioning with a venturi is not new, but the particular design described here is novel and has advantages compared with earlier arrangements.

In investigating the production of spray and foaming agent solutions, the authors needed a continuous mixing device which would be accurate and dependable and could mix a few percent of agent into a main water stream. It was necessary that the device operate with a minimum of attention and be flexible enough to work at varying water pressures without adjustment. Also, it was necessary to obtain the greatest possible suction while keeping the pressure drop to a minimum. This meant introducing the secondary stream into the main stream in the venturi throat with a minimum disturbance of the flow pattern of the main stream. Otherwise distortion of the main stream would produce eddies and excessive friction in the

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★ October Contest Prize Winner

"How to Use an Intensive Mixer in Drying Rubber and Similar Materials."

A prize of $50 in cash will be awarded to Anthony P. Massa, project engineer and production supervisor, Stein Hall & Co., Long Island City, N. Y. The prize winning entry will appear in the December issue.

$50 PRIZE FOR A GOOD IDEA—Until further notice the Editors of *Chemical Engineering* will award $50 cash each month to the author of the best short article received that month and accepted for publication in the Plant Notebook.

The winner each month will be announced in the issue of the next month, e.g., the November winner will be announced in December and his article published in January. Judges will be editors of *Chemical Engineering*. Non-winning articles submitted for this contest will be published if acceptable at space rates.

HOW TO ENTER CONTEST—Any reader of *Chemical Engineering*, other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible.

Articles may deal with any sort of plant or production "kink" or short-cut that will be of interest to chemical engineers or others in the process industries. Also, novel means of presenting useful data are acceptable. Address Plant Notebook Editor, *Chemical Engineering*, 330 West 42nd St., New York 18, N. Y.

Ye Old Spanish Swindle

Have you heard recently from Sr. Pedro Ceballos of Mexico City? It seems the poor man has been jailed for bankruptcy, despite the fact that he has carefully cached a trunk full of U.S. currency which he would be glad to share with you—for a consideration. And there's a sick daughter involved, too, further to incite your sympathies and to assuage your conscience in case you have moral scruples against entering into Pedro's little plot.

So many of our chemical friends have been approached recently, we begin to think that Pedro has been using the new ACS directory for his sucker list. The typing of the present letter and the air-mailed envelope certainly have all the earmarks of mass production. Although the amount is different, the wording is identical with the first such letter we received at least five years ago. This time we turned the file over to the local postmaster and received his written assurance that the postal authorities "will do all they can to stamp (sic) out the thing you complain of."

A few days later word came from the Post Office Inspector in Philadelphia that the Postmaster General has been on the trail of Pedro and his many aliases for many years. Too often gullible Americans have been persuaded by these swindlers to take ransom money into Mexico, only to be relieved of it by trickery or violence. Fraud orders have been issued to impound U.S. mail addressed to any of the known names used by the swindlers. But so far the authorities have not been able to apprehend and punish those co-conspirators in the United States who furnish the lists and otherwise promote this fraudulent scheme. For the experience of others, see page 264.

Higher Gas Costs Coming

For some time quietly, now more conspiciously, the federal authorities have been intent on reducing the demand for natural gas for space heating. It has long been evident to engineers acquainted with the gas business that such restriction or control might ultimately be necessary. Since chemical industries are going to be involved as large fuel users, as well as producers, this is now a problem for the serious consideration of chemical engineers and executives.

Huge pipelines have been built to bring natural gas from Texas and nearby states to serve almost the entire area of the United States. Pipelines originating in the Lone Star State deliver gas to Boston and New England cities, to San Francisco and the West Coast and as far north as Minneapolis. The gas industry's wildest dreams of ten years ago have now been realized. But three sorts of troubles have developed, all of them important to us:

1. Increasing demand for gas in the producing areas has driven the price up rapidly. In some cases gas is now sold at the well for three to ten times as much as the same gas could command only ten or fifteen years ago.

2. Most of the pipelines have become interlocked with public utility distributing systems. This means that much of the customer load is at a very low capacity load factor. In many cities the unrestrained sale is resulting in 35 to 40 percent load factors, thus making the capital cost for transmission from 2½ to 3 times as much as would be the case for uniform load customers. Delivered gas prices threaten to become excessive.

3. Because these higher costs can often be passed on to the ultimate consumer in a utility system, there is danger that the more desirable chemical-industry customer will also be charged excessively or may find that he cannot get needed gas at all, even though his high load factor makes him almost invariably the most favorable customer from the standpoint of the pipeline systems.

It is not feasible here to offer remedies for these three difficulties and their many variations. But there is both time and need for a word of warning to chemical management: it must get busy. It must soon demonstrate that the greatest public good from long-distance transmission of natural gas can come only from a combination of base-load industrial customers and a proper system of utility distribution in the urban areas. Without such a combination our irreplaceable natural-gas reserves are going to be dissipated wastefully for the benefit of none but a few exploiters of this great resource.

Time to Retreat?

For various reasons the gas industry in recent years has been getting rid of its manufacturing plants and has supplied whole utility systems with natural gas unmixed with manufactured components. In view of the developments to which we have just referred, it appears that the temporary financial advantage in such operations no longer exists. A strategic retreat is in order.

Unmixed natural gas can no longer be supplied at an economic price in utility systems of low capacity load factor. Added space-heating loads, especially for individual homes, creates a capital burden too great to be tolerated. They also make the manufacture of peak-load gas either impossible or excessively expensive.

Fortunately, a few big cities have been wise enough to retain the old city gas works for possible conversion to specialized gas manufacture. Those that have done away with these plant facilities are now confronted with the necessity of building new equipment and getting ready to supply part of the base load and most of the extra peak-load gas from these manufacturing plants.

diverging discharge portion of the venturi, thus increasing the pressure loss and reducing the suction.

The first effort at adapting a standard venturi by drilling into the throat at right angles was not very successful, owing to increased pressure loss and unreliable suction. Therefore, new venturis were designed in an attempt to avoid this disturbance. One design which proved eminently satisfactory is shown in Fig. 1. It was made of aluminum, for ease in machining and for lightness, with a connecting length of steel for strength in joining to the line. The approach and diffuser angles, of 20 and 7 deg. respectively, are the standard venturi angles. The important deviation from ordinary design lies in the throat. Here a gradual and smooth mixing of the two streams is achieved by putting the secondary intake hole into the throat at an angle of 60 deg. from the throat axis. This hole leads into a narrow tapering groove along the throat so that when the side stream is drawn into the recession, as it tapers to zero depth, the liquid mixes smoothly into the main stream. Performance shows a marked improvement compared with a standard venturi.

For cases where intermittent service is required, with a shutoff valve in the main stream after the venturi, a check valve can be installed in the side inlet as shown in the drawing. Or, if it is desired to vary the proportion of liquid admitted by the side inlet, a needle valve can be used instead of a check valve. Obviously, to enable the maximum proportion of side stream liquid to be drawn in, the side connection (and any valves installed in it) must be as large as can conveniently be accommodated. The effect of reducing the size of check valve is shown in Fig. 3. This chart shows both that there is a marked decrease in the percent of side stream that can be drawn in with the smaller check valve, and that for any size check valve the percent of side stream drawn in will decrease as the venturi inlet pressure and main stream flow increase.

Fig. 3 also shows the effect of varying viscosity of the side stream. The dotted curve is based on a venturi inlet pressure of 50 psig. and a main stream flow rate of 5.6 gpm. As the viscosity increases in the side stream, relative to water at 28.7 SSU. at room temperature, the suction rate decreases as would be expected, since the side stream liquid is in viscous flow in the $\frac{3}{32}$ in. intake line.

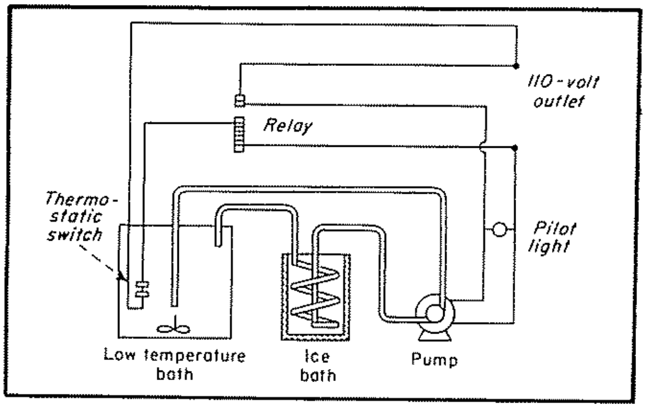
Another important feature of the proportioner is the constant flow rate obtainable over a considerable range of back pressure. Fig. 4 shows the effect on main stream flow of varying the back pressure for various constant values of the inlet pressure of the main stream. For each inlet pressure value the flow remains substantially constant until the back pressure reaches 75 to 80 percent of the inlet pressure. Also, over this range, there is essentially no change in suction rate. This means that, so long as the inlet pressure remains constant, there will be no change in the proportion of side stream mixed in, regardless of variations in the back pressure.

Hydrometer Cylinders Made Safe For Handling Corrosives

Otto A. Holstein, *Atlantic Refining Co., Philadelphia.*

Control of operations in a sulphuric acid plant requires hourly determinations of the Baumé specific gravity of acids of 93, 98 and 105 percent H_2SO_4 strength. In a recent accident with an ordinary hydrometer cylinder, the operator allowed the cylinder to slip through his gloved hand, so as to strike the lead work table and splash acid on his arm and face.

Although the burns were minor it was desirable to minimize the possibilities for future accidents of this sort. Therefore, we had the glassblowing section put a circumferential bulge in the center of the straight glass cylinder, and roughen the lower part of the cylinder by sandblasting. Modifying the standard cylinder in this way provides a positive grip without danger of slippage which is inherent in a straight-walled cylinder. The treatment does not interfere with the visibility of the upper section of the cylinder. So far as we have been able to determine, there are no hydrometer cylinders of this design commercially available.



Easily Constructed Water Bath Holds Sub-Atmospheric Temperatures

H. E. Payne *and* A. L. Minto, *Hollingsworth and Whitney Co., Mobile, Ala.*

Occasionally a need arises for a constant-temperature water bath below room temperature. This is especially true when checking viscosities and specific gravities. It was for uses of this sort that the writers devised the apparatus described below.

This bath is a relatively simple modification of the standard water bath for elevated temperatures. The thermostatic switch is connected in series with a relay coil, and the pump motor in series with the relay breaker points. If the bath temperature rises above the control point, then the thermostatic switch opens, thereby de-energizing the relay coil. This allows the relay points to close which starts the pump motor. In effect, this reverses the action of the thermostat as used for elevated temperatures. When enough water has been circulated to bring the temperature down to the control point, the action of the thermostatic switch breaks the pump motor circuit.

This particular apparatus maintains the water bath at a constant temperature within ±0.1 deg. C. when the temperature is as low as 5 deg. C. The control temperature can be reached faster if ice is added directly to the bath until the water temperature just approaches the desired point before starting the pump motor.

A Fenwal No. 17500 general-purpose Thermoswitch, with a range of −100 to +400 deg. F. is used. The pump delivers about 0.5 gpm. through 13 ft. of 3/16-in. copper tubing, coiled in 4-in. diameters. A 12 by 12-in. glass jar is used for the water bath while a well-insulated 6 by 8½-in. glass jar serves as the container for the ice bath. An electric stirrer in the bath insures an even temperature throughout.

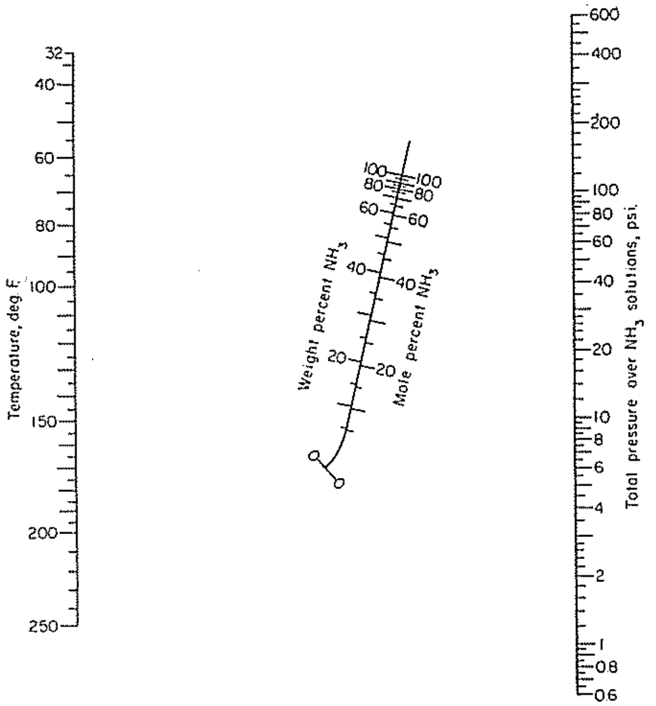


Chart Gives Total Pressures Over Aqueous Ammonia Solutions

D. S. Davis, *Virginia Polytechnic Inst., Blacksburg, Va.*

Wilson's data[2] that deal with the total pressures over aqueous solutions of ammonia for wide concentration and temperature ranges can be correlated very satisfactorily by means of the equation $P_m = aP_w{}^b$ where P_m = total pressure over the aqueous solution, pounds per sq. in.; P_w = vapor pressure of water at the same temperature; and a and b depend upon the concentration of ammonia as shown in the table:

Mole Percent of Ammonia	a	b	Temperature Range, Deg. F.
5	2.727	0.8463	32–250
10	4.224	0.8118	32–250
15	6.397	0.7809	32–250
20	9.727	0.7491	32–250
25	14.76	0.7180	32–250
30	22.12	0.6876	32–250
35	32.28	0.6602	32–250
40	45.68	0.6349	32–250
45	62.09	0.6129	32–250
50	81.08	0.5935	32–240
55	101.2	0.5763	32–220
60	121.1	0.5642	32–210
65	139.5	0.5536	32–200
70	155.5	0.5453	32–190
75	168.7	0.5384	32–180
80	179.2	0.5346	32–180
85	187.9	0.5313	32–180
90	196.4	0.5278	32–170
95	205.9	0.5239	32–170
100	218.8	0.5198	32–170

Since Wilson's data cover total pressure for solutions in steps of 5 mole percent of ammonia and in steps of 10 deg. F., there is evident need for a convenient graphical presentation that will permit close estimation of total pressure at any concentration and temperature within the ranges of the original investigation. The accompanying line coordinate chart, based on the tabulated values of a and b and constructed by methods described previously,[1] meets these requirements.

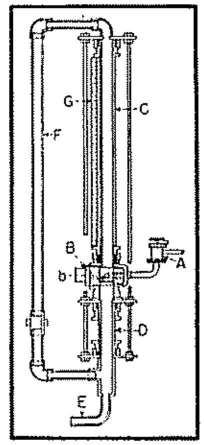
The use of the chart is illustrated as follows: What is the total pressure over an aqueous solution that contains 48 mole percent (46.6 weight percent) of ammonia at 85 deg. F.? A straight line connecting 85 on the temperature scale with 48 on the mole percentage scale can be extended to cut the total pressure scale at the desired value of 55 psi. What is the weight percentage of ammonia in an aqueous solution that exerts a total pressure of 38 psi. at 125 deg. F.? A line connecting 125 on the temperature scale and 38 on the total pressure scale intersects the concentration scale of 30 weight percent (31.2 mole percent) of ammonia.

References

1. Davis, D. S., "Empirical Equations and Nomography," Chap. VII, McGraw-Hill Book Co., Inc., New York (1943).
2. Wilson, Univ. Ill., Expe. Sta. Bull. 146.

Removable Orifice Improves Operation Of Head Type Flowmeter

I. Bergman, *Chemical Engineer, Klipfontein Organic Products, Chloorkop P. O., Johannesburg, South Africa.*



During the course of some pilot plant investigations it became necessary to meter accurately some very low continuous benzene flow rates, in the order of 0.3 gph. As no suitable rotameter or other meter was available locally, we designed and installed a flowmeter of the "niveau" type. This type, of course, depends on a head of liquid over an orifice of determined size. Varying the head alters the flow rate accordingly. The flow is a function of the square root of the head. By plotting head against flow on log-log paper or by using linear ordinates and squared abscissas, a straight line is obtained.

The required orifice size in this case was about 0.025 in. and this was drilled into a plate. However, we experienced constant difficulties with blocking or partial blocking of this small orifice.

We found that the task of removing and re-installing the orifice plate caused much inconvenience and unduly long interruptions in the continuity of the process. It became necessary to re-design the meter so that the metering element could be removed, cleaned and reassembled by the operator in a minimum of time.

The design adopted is shown in the diagram. For the orifice plate a plug cock B was substituted. Into the hole of the plug a plate b was welded, drilled for a 0.025 in. diam. orifice. Benzene from a head tank passes via needle valve A through a hole drilled into the body of the plug cock, and through a mating hole at the center of the plug just above the orifice. When cleaning of the orifice becomes necessary, all that is required is to remove the plug, clean and re-insert the orifice. This operation requires only a few minutes.

A description of the rest of the meter follows: Part C is a 1-in. sight glass tubing, fitting into a gland on the upper part of B. The liquid level is maintained in this sight glass and its height above the orifice read on scale G. It fits into another gland at the top end, the total height being made to suit the flow range required. A similar smaller sight glass D is fitted below B, to observe the stream passing through the orifice. One can therefore tell at a glance whether the orifice is perfectly clear or not. The section E delivers the liquid to the plant, while F is a balancing pipe to equalize pressures above and below the orifice.