PLC Implementation as a Flow Computer for Calculation of Saturated Steam Mass Meetings with the Linear Divided Regression Method. (Application: PT. XYZ - Kuala Tanjung)

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ABSTRACT
In supporting of production quality improvement, industry must be supported by reliable process system. Reliable measurement system also included in one system which is expected realibility. Specially for saturated steam flow measurement and calculation which is mostly done in the industry in relation to control production cost, should also be able to show accurate results. Now PLC has taken an important role in industry, beside as a control system, PLC also can be used to calculation a formula. This paper aims to use PLC as flow computer to calculate saturated steam density by adopting linear regression method which is divided into “n” section to increase the accuracy with pressure as a input parameter. The results show a relatively small error value around 0.2% if we compare with standard linear regression method, where the value around 0.9%.

Keyword: Saturated Steam Density, Flow Computer, Linear Regression, PLC.

1. INTRODUCTION
Currently the industrial world is very strict in terms of quality competition for a product to boost sales. In order to produce good quality products, a production process must be fully supported by a reliable process system. One component of the system is a measurement system.

Steam flow measurement is mostly done in almost every type of industry, because one of the energy sources used is heat energy from steam. Whereas for this flow measuring instrument are very many types, one of which is a type of vortex. In general, the flowmeter vortex can only display the value of the flow size in the form of a volume that is converted from the frequency vortex itself. To get the value of the quantity in the form of mass, a tool is needed to calculate the density value (mass density) which is usually called a flow computer.

To calculate the value of mass flow magnitude can be used the following general equation:

\[ M = V \times \rho \] (1)

Where:
- \( M \): Mass flow (kG/hour)
- \( V \): Volume flow (m³/hour)
- \( \rho \): Mass meeting (kG/m³)

The value of \( \rho \) (mass density) itself in a saturated vapor system has a linear relationship that is directly proportional to the value of the vapor pressure. The accuracy of the mass density calculation greatly affects the accuracy of the value of the mass flow, so that the small magnitude of the error value becomes a benchmark of the error value of the steam mass flow.
In this paper, we will try to offer a method of mass density calculation with a much better level of accuracy through the linear regression method approach adopted into the PLC as an alternative to the *flow computer* function that is currently widely used in industry.

2. **LITERATURE REVIEW**

The use of linear regression methods has been used in many writings which aim to determine the relationship between two values or parameters. Linear regression is also widely adopted to *formulate* several problems into a form of calculation, so that they can be used to forecast or predict a value in the future.

Intan diantari et al (2015) uses linear regression to overcome excess and lack of vehicle stock at Anugrah Utama Motor. Hotanto et al (2015) uses linear regression to forecast fuel sales in the future to avoid losses due to excess stock when there is a change from high to low fuel prices. Multiple linear regression method was used by Jamner R. Lawendatu et al (2014) to analyze the income of nutmeg farmers in Sangihe Islands District - North Sulawesi. As for the prediction of electric power requirements for Lampung Province until 2030 using linear regression has been carried out by M. Syafrudin et al (2014).

In this paper, the linear system method will be implemented as a formula in the PLC program to calculate the mass meeting value in saturated vapor based on the value of the vapor pressure, so that a more accurate value can be obtained.

3. **METHOD**

a. Research Steps.

The steps adopted in this study can be seen in Figure 1 below. Based on the picture, collecting initial data on the relationship between mass meetings and pressure from credible sources is the first thing to do. Then with this data we divide into several segments into "n" to increase its accuracy and calculate the regression value of each segment, where in this case it is determined n = 5. The formula of each of these ranges is then entered into the PLC program as a formula for calculating steam mass meetings. Then an evaluation of the *error* between the initial mass meeting data from the reference source and the formula mass meeting data and determine the percentage *error*.

![Flow Chart](image)

*Figure 1. Research Flow Chart*

b. Research Equipment.

In this study the equipment that will function as a *flow computer* is the Nano-Micro Versamax IC200UDR005 PLC with the following specifications.

- **Brand**: General Electric
- **Series**: Versamax Nano / Micro

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**Power:** 100 ~ 240 VAC  
**Input:** 16 DC Input  
**Output:** 11 + 1 Output

![Versamax Nano / Micro PLC](image)

**Figure 2. Versamax Nano / Micro PLC.**

a. **Used Data.**  
The data used in this study were taken from mass density values based on the saturated vapor pressure of Spirax Sarco database as shown in the following table.

| Pressure (bar gauge) | Density of Steam (kg/m³) | Pressure (bar gauge) | Density of Steam (kg/m³) | Pressure (bar gauge) | Density of Steam (kg/m³) | Pressure (bar gauge) | Density of Steam (kg/m³) | Pressure (bar gauge) | Density of Steam (kg/m³) |
|----------------------|--------------------------|----------------------|--------------------------|----------------------|--------------------------|----------------------|--------------------------|----------------------|--------------------------|
| 0.0                  | 0.598                    | 3.1                  | 2.220                    | 6.1                  | 3.722                    | 9.1                  | 5.200                    | 12.1                 | 6.669                    |
| 0.1                  | 0.653                    | 3.2                  | 2.271                    | 6.2                  | 3.771                    | 9.2                  | 5.249                    | 12.2                 | 6.718                    |
| 0.2                  | 0.707                    | 3.3                  | 2.321                    | 6.3                  | 3.821                    | 9.3                  | 5.298                    | 12.3                 | 6.767                    |
| 0.3                  | 0.762                    | 3.4                  | 2.372                    | 6.4                  | 3.870                    | 9.4                  | 5.347                    | 12.4                 | 6.816                    |
| 0.4                  | 0.816                    | 3.5                  | 2.422                    | 6.5                  | 3.920                    | 9.5                  | 5.396                    | 12.5                 | 6.865                    |
| 0.5                  | 0.870                    | 3.6                  | 2.473                    | 6.6                  | 3.969                    | 9.6                  | 5.445                    | 12.6                 | 6.914                    |
| 0.6                  | 0.923                    | 3.7                  | 2.523                    | 6.7                  | 4.019                    | 9.7                  | 5.494                    | 12.7                 | 6.963                    |
| 0.7                  | 0.977                    | 3.8                  | 2.574                    | 6.8                  | 4.068                    | 9.8                  | 5.543                    | 12.8                 | 7.012                    |
| 0.8                  | 1.030                    | 3.9                  | 2.624                    | 6.9                  | 4.117                    | 9.9                  | 5.592                    | 12.9                 | 7.060                    |
| 0.9                  | 1.083                    | 4.0                  | 2.674                    | 7.0                  | 4.167                    | 10.0                 | 5.641                    | 13.0                 | 7.109                    |
| 1.0                  | 1.136                    | 4.1                  | 2.725                    | 7.1                  | 4.216                    | 10.1                 | 5.690                    | 13.1                 | 7.158                    |
| 1.1                  | 1.189                    | 4.2                  | 2.775                    | 7.2                  | 4.265                    | 10.2                 | 5.739                    | 13.2                 | 7.207                    |
| 1.2                  | 1.241                    | 4.3                  | 2.825                    | 7.3                  | 4.315                    | 10.3                 | 5.788                    | 13.3                 | 7.256                    |
| 1.3                  | 1.294                    | 4.4                  | 2.875                    | 7.4                  | 4.364                    | 10.4                 | 5.837                    | 13.4                 | 7.305                    |
| 1.4                  | 1.346                    | 4.5                  | 2.925                    | 7.5                  | 4.413                    | 10.5                 | 5.886                    | 13.5                 | 7.354                    |
| 1.5                  | 1.398                    | 4.6                  | 2.975                    | 7.6                  | 4.463                    | 10.6                 | 5.935                    | 13.6                 | 7.403                    |
| 1.6                  | 1.450                    | 4.7                  | 3.025                    | 7.7                  | 4.512                    | 10.7                 | 5.984                    | 13.7                 | 7.452                    |
| 1.7                  | 1.502                    | 4.8                  | 3.075                    | 7.8                  | 4.561                    | 10.8                 | 6.033                    | 13.8                 | 7.501                    |
| 1.8                  | 1.554                    | 4.9                  | 3.125                    | 7.9                  | 4.610                    | 10.9                 | 6.082                    | 13.9                 | 7.549                    |
| 1.9                  | 1.606                    | 5.0                  | 3.175                    | 8.0                  | 4.660                    | 11.0                 | 6.131                    | 14.0                 | 7.598                    |
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Table 2. Calculation of mass meetings with an interval formula divided by 5

| Pressure (bar gauge) | Density of Steam (kg/m³) | Pressure (bar gauge) | Density of Steam (kg/m³) | Pressure (bar gauge) | Density of Steam (kg/m³) | Pressure (bar gauge) | Density of Steam (kg/m³) |
|---------------------|--------------------------|---------------------|--------------------------|---------------------|--------------------------|---------------------|--------------------------|
| 0.0                 | 0.608                    | 3.1                 | 2.220                    | 6.1                 | 3.717                    | 9.1                 | 5.194                    | 12.1                   | 6.669                   |
| 0.1                 | 0.660                    | 3.2                 | 2.220                    | 6.1                 | 3.717                    | 9.1                 | 5.243                    | 12.2                   | 6.718                   |
| 0.2                 | 0.712                    | 3.3                 | 2.320                    | 6.2                 | 3.865                    | 9.4                 | 5.341                    | 12.4                   | 6.816                   |
| 0.3                 | 0.765                    | 3.4                 | 2.390                    | 6.4                 | 3.914                    | 9.5                 | 5.390                    | 12.5                   | 6.865                   |
| 0.4                 | 0.817                    | 3.5                 | 2.450                    | 6.5                 | 4.062                    | 9.8                 | 5.536                    | 12.8                   | 7.011                   |
| 0.5                 | 0.869                    | 3.6                 | 2.470                    | 6.6                 | 3.963                    | 9.6                 | 5.438                    | 12.6                   | 6.913                   |
| 0.6                 | 0.921                    | 3.7                 | 2.520                    | 6.7                 | 4.012                    | 9.7                 | 5.487                    | 12.7                   | 6.962                   |
| 0.7                 | 0.973                    | 3.8                 | 2.570                    | 6.8                 | 4.062                    | 9.8                 | 5.536                    | 12.8                   | 7.011                   |
| 0.8                 | 1.026                    | 3.9                 | 2.620                    | 6.9                 | 4.111                    | 9.9                 | 5.585                    | 12.9                   | 7.060                   |
| 0.9                 | 1.078                    | 4.0                 | 2.670                    | 7.0                 | 4.160                    | 10.0                | 5.634                    | 13.0                   | 7.109                   |
| 1.0                 | 1.130                    | 4.1                 | 2.720                    | 7.1                 | 4.209                    | 10.1                | 5.683                    | 13.1                   | 7.158                   |
| 1.1                 | 1.182                    | 4.2                 | 2.770                    | 7.2                 | 4.258                    | 10.2                | 5.732                    | 13.2                   | 7.207                   |
| 1.2                 | 1.234                    | 4.3                 | 2.820                    | 7.3                 | 4.308                    | 10.3                | 5.781                    | 13.3                   | 7.256                   |
| 1.3                 | 1.287                    | 4.4                 | 2.870                    | 7.4                 | 4.357                    | 10.4                | 5.830                    | 13.4                   | 7.305                   |
| 1.4                 | 1.339                    | 4.5                 | 2.920                    | 7.5                 | 4.406                    | 10.5                | 5.879                    | 13.5                   | 7.354                   |
| 1.5                 | 1.391                    | 4.6                 | 2.970                    | 7.6                 | 4.456                    | 10.6                | 5.927                    | 13.6                   | 7.402                   |
| 1.6                 | 1.443                    | 4.7                 | 3.020                    | 7.7                 | 4.504                    | 10.7                | 5.976                    | 13.7                   | 7.451                   |
| 1.7                 | 1.495                    | 4.8                 | 3.070                    | 7.8                 | 4.554                    | 10.8                | 6.025                    | 13.8                   | 7.500                   |
| 1.8                 | 1.548                    | 4.9                 | 3.120                    | 7.9                 | 4.603                    | 10.9                | 6.074                    | 13.9                   | 7.549                   |
| 1.9                 | 1.600                    | 5.0                 | 3.170                    | 8.0                 | 4.652                    | 11.0                | 6.123                    | 14.0                   | 7.598                   |
| 2.0                 | 1.652                    | 5.1                 | 3.220                    | 8.1                 | 4.701                    | 11.1                | 6.172                    | 14.1                   | 7.647                   |
| 2.1                 | 1.704                    | 5.2                 | 3.270                    | 8.2                 | 4.750                    | 11.2                | 6.221                    | 14.2                   | 7.696                   |
| 2.2                 | 1.756                    | 5.3                 | 3.320                    | 8.3                 | 4.800                    | 11.3                | 6.270                    | 14.3                   | 7.745                   |
| 2.3                 | 1.809                    | 5.4                 | 3.370                    | 8.4                 | 4.849                    | 11.4                | 6.319                    | 14.4                   | 7.794                   |
| 2.4                 | 1.861                    | 5.5                 | 3.420                    | 8.5                 | 4.898                    | 11.5                | 6.368                    | 14.5                   | 7.843                   |
| 2.5                 | 1.913                    | 5.6                 | 3.470                    | 8.6                 | 4.947                    | 11.6                | 6.416                    | 14.6                   | 7.891                   |
| 2.6                 | 1.965                    | 5.7                 | 3.520                    | 8.7                 | 4.996                    | 11.7                | 6.465                    | 14.7                   | 7.940                   |
| 2.7                 | 2.017                    | 5.8                 | 3.570                    | 8.8                 | 5.046                    | 11.8                | 6.514                    | 14.8                   | 7.989                   |
| 2.8                 | 2.070                    | 5.9                 | 3.620                    | 8.9                 | 5.095                    | 11.9                | 6.563                    | 14.9                   | 8.038                   |
| 2.9                 | 2.122                    | 6.0                 | 3.670                    | 9.0                 | 5.144                    | 12.0                | 6.612                    | 15.0                   | 8.087                   |
| 3.0                 | 2.174                    |                     |                         |                     |                         |                     |                         |                        |                        |

To see accuracy needs to be calculated relative error values as shown in the following table, where the average percentage error value of the overall value is 0.2%.

Table 3. Calculation of mass meeting errors with a formula of 5 values.
### PLC Implementation as a Flow Computer for Calculation of Saturated Steam Mass \( M \) Using the Linear Divided Regression Method. (Dedi)

| Pressure (bar gauge) | Density of Steam (kg/m³) | Density of Steam (kg/m³) | Density of Steam (kg/m³) | Density of Steam (kg/m³) | Density of Steam (kg/m³) | Density of Steam (kg/m³) |
|----------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 0.0                  | 1.8%                     | 3.1%                     | 0.0%                     | 6.1%                     | 0.1%                     | 9.1%                     | 0.1%                     | 12.1%                     | 0.0%                     |
| 0.1                  | 1.2%                     | 3.2%                     | 0.0%                     | 6.2%                     | 0.1%                     | 9.2%                     | 0.1%                     | 12.2%                     | 0.0%                     |
| 0.2                  | 0.7%                     | 3.3%                     | 0.1%                     | 6.3%                     | 0.1%                     | 9.3%                     | 0.1%                     | 12.3%                     | 0.0%                     |
| 0.3                  | 0.4%                     | 3.4%                     | 0.1%                     | 6.4%                     | 0.1%                     | 9.4%                     | 0.1%                     | 12.4%                     | 0.0%                     |
| 0.4                  | 0.1%                     | 3.5%                     | 0.1%                     | 6.5%                     | 0.1%                     | 9.5%                     | 0.1%                     | 12.5%                     | 0.0%                     |
| 0.5                  | 0.1%                     | 3.6%                     | 0.1%                     | 6.6%                     | 0.2%                     | 9.6%                     | 0.1%                     | 12.6%                     | 0.0%                     |
| 0.6                  | 0.2%                     | 3.7%                     | 0.1%                     | 6.7%                     | 0.2%                     | 9.7%                     | 0.1%                     | 12.7%                     | 0.0%                     |
| 0.7                  | 0.3%                     | 3.8%                     | 0.1%                     | 6.8%                     | 0.2%                     | 9.8%                     | 0.1%                     | 12.8%                     | 0.0%                     |
| 0.8                  | 0.4%                     | 3.9%                     | 0.2%                     | 6.9%                     | 0.2%                     | 9.9%                     | 0.1%                     | 12.9%                     | 0.0%                     |
| 0.9                  | 0.5%                     | 4.0%                     | 0.2%                     | 7.0%                     | 0.2%                     | 10.0%                    | 0.1%                     | 13.0%                     | 0.0%                     |
| 1.0                  | 0.5%                     | 4.1%                     | 0.2%                     | 7.1%                     | 0.2%                     | 10.1%                    | 0.1%                     | 13.1%                     | 0.0%                     |
| 1.1                  | 0.5%                     | 4.2%                     | 0.2%                     | 7.2%                     | 0.2%                     | 10.2%                    | 0.1%                     | 13.2%                     | 0.0%                     |
| 1.2                  | 0.5%                     | 4.3%                     | 0.2%                     | 7.3%                     | 0.2%                     | 10.3%                    | 0.1%                     | 13.3%                     | 0.0%                     |
| 1.3                  | 0.5%                     | 4.4%                     | 0.2%                     | 7.4%                     | 0.2%                     | 10.4%                    | 0.1%                     | 13.4%                     | 0.0%                     |
| 1.4                  | 0.5%                     | 4.5%                     | 0.2%                     | 7.5%                     | 0.2%                     | 10.5%                    | 0.1%                     | 13.5%                     | 0.0%                     |
| 1.5                  | 0.5%                     | 4.6%                     | 0.2%                     | 7.6%                     | 0.2%                     | 10.6%                    | 0.1%                     | 13.6%                     | 0.0%                     |
| 1.6                  | 0.5%                     | 4.7%                     | 0.2%                     | 7.7%                     | 0.2%                     | 10.7%                    | 0.1%                     | 13.7%                     | 0.0%                     |
| 1.7                  | 0.4%                     | 4.8%                     | 0.2%                     | 7.8%                     | 0.2%                     | 10.8%                    | 0.1%                     | 13.8%                     | 0.0%                     |
| 1.8                  | 0.4%                     | 4.9%                     | 0.2%                     | 7.9%                     | 0.2%                     | 10.9%                    | 0.1%                     | 13.9%                     | 0.0%                     |
| 1.9                  | 0.4%                     | 5.0%                     | 0.2%                     | 8.0%                     | 0.2%                     | 11.0%                    | 0.1%                     | 14.0%                     | 0.0%                     |
| 2.0                  | 0.3%                     | 5.1%                     | 0.1%                     | 8.1%                     | 0.2%                     | 11.1%                    | 0.1%                     | 14.1%                     | 0.0%                     |
| 2.1                  | 0.3%                     | 5.2%                     | 0.1%                     | 8.2%                     | 0.2%                     | 11.2%                    | 0.1%                     | 14.2%                     | 0.0%                     |
| 2.2                  | 0.2%                     | 5.3%                     | 0.1%                     | 8.3%                     | 0.2%                     | 11.3%                    | 0.1%                     | 14.3%                     | 0.0%                     |
| 2.3                  | 0.2%                     | 5.4%                     | 0.1%                     | 8.4%                     | 0.2%                     | 11.4%                    | 0.1%                     | 14.4%                     | 0.0%                     |
| 2.4                  | 0.1%                     | 5.5%                     | 0.1%                     | 8.5%                     | 0.2%                     | 11.5%                    | 0.1%                     | 14.5%                     | 0.0%                     |
| 2.5                  | 0.1%                     | 5.6%                     | 0.1%                     | 8.6%                     | 0.1%                     | 11.6%                    | 0.1%                     | 14.6%                     | 0.0%                     |
| 2.6                  | 0.0%                     | 5.7%                     | 0.1%                     | 8.7%                     | 0.1%                     | 11.7%                    | 0.1%                     | 14.7%                     | 0.0%                     |
| 2.7                  | 0.1%                     | 5.8%                     | 0.1%                     | 8.8%                     | 0.1%                     | 11.8%                    | 0.1%                     | 14.8%                     | 0.0%                     |
| 2.8                  | 0.1%                     | 5.9%                     | 0.1%                     | 8.9%                     | 0.1%                     | 11.9%                    | 0.1%                     | 14.9%                     | 0.0%                     |
| 2.9                  | 0.2%                     | 6.0%                     | 0.1%                     | 9.0%                     | 0.1%                     | 12.0%                    | 0.1%                     | 15.0%                     | 0.0%                     |
| 3.0                  | 0.2%                     |
From the graph above, the regression formula can be determined without the following range of values:

\[ y = 0.4963x + 0.6714 \]

By formulating the above equation into the PLC program, the mass meeting values are as follows:

| Pressure (Barg) | Density of Steam (kg/m³) | Pressure (Barg) | Density of Steam (kg/m³) | Pressure (Barg) | Density of Steam (kg/m³) | Pressure (Barg) | Density of Steam (kg/m³) |
|----------------|--------------------------|----------------|--------------------------|----------------|--------------------------|----------------|--------------------------|
| 0.0            | 0.671                    | 3.1            | 2.209                    | 6.1            | 3.697                    | 9.1            | 5.185                    |
| 0.1            | 0.721                    | 3.2            | 2.258                    | 6.2            | 3.746                    | 9.2            | 5.234                    |
| 0.2            | 0.770                    | 3.3            | 2.308                    | 6.3            | 3.796                    | 9.3            | 5.284                    |
| 0.3            | 0.820                    | 3.4            | 2.357                    | 6.4            | 3.845                    | 9.4            | 5.333                    |
| 0.4            | 0.869                    | 3.5            | 2.407                    | 6.5            | 3.895                    | 9.5            | 5.383                    |
| 0.5            | 0.919                    | 3.6            | 2.457                    | 6.6            | 3.945                    | 9.6            | 5.433                    |
| 0.6            | 0.969                    | 3.7            | 2.506                    | 6.7            | 3.994                    | 9.7            | 5.482                    |
| 0.7            | 1.018                    | 3.8            | 2.556                    | 6.8            | 4.044                    | 9.8            | 5.532                    |
| 0.8            | 1.068                    | 3.9            | 2.605                    | 6.9            | 4.093                    | 9.9            | 5.581                    |
| 0.9            | 1.117                    | 4.0            | 2.655                    | 7.0            | 4.143                    | 10.0           | 5.631                    |
| 1.0            | 1.167                    | 4.1            | 2.705                    | 7.1            | 4.193                    | 10.1           | 5.681                    |
| 1.1            | 1.217                    | 4.2            | 2.754                    | 7.2            | 4.242                    | 10.2           | 5.730                    |
| 1.2            | 1.266                    | 4.3            | 2.804                    | 7.3            | 4.292                    | 10.3           | 5.780                    |
| 1.3            | 1.316                    | 4.4            | 2.853                    | 7.4            | 4.341                    | 10.4           | 5.829                    |
| 1.4            | 1.365                    | 4.5            | 2.903                    | 7.5            | 4.391                    | 10.5           | 5.879                    |
| 1.5            | 1.415                    | 4.6            | 2.953                    | 7.6            | 4.441                    | 10.6           | 5.929                    |
| 1.6            | 1.465                    | 4.7            | 3.002                    | 7.7            | 4.490                    | 10.7           | 5.979                    |
| 1.7            | 1.514                    | 4.8            | 3.052                    | 7.8            | 4.540                    | 10.8           | 6.028                    |

Figure 4. Graph of mass density vs. vapor pressure regression without being divided into n.
With a percentage error of 0.9% as shown in the following table:

Table 5. Calculation of mass density errors without value ranges

| Pressure (bar gauge) | Density of Steam (kg/m³) | Pressure (bar gauge) | Density of Steam (kg/m³) | Pressure (bar gauge) | Density of Steam (kg/m³) | Pressure (bar gauge) | Density of Steam (kg/m³) |
|----------------------|--------------------------|----------------------|--------------------------|----------------------|--------------------------|----------------------|--------------------------|
| 0.0                  | 12.3%                    | 3.1                  | 0.5%                     | 6.1                  | 0.7%                     | 9.1                  | 0.3%                     | 12.1                   | 0.1%                     |
| 0.1                  | 10.4%                    | 3.2                  | 0.5%                     | 6.2                  | 0.7%                     | 9.2                  | 0.3%                     | 12.2                   | 0.1%                     |
| 0.2                  | 8.9%                     | 3.3                  | 0.6%                     | 6.3                  | 0.7%                     | 9.3                  | 0.3%                     | 12.3                   | 0.1%                     |
| 0.3                  | 7.6%                     | 3.4                  | 0.6%                     | 6.4                  | 0.6%                     | 9.4                  | 0.3%                     | 12.4                   | 0.1%                     |
| 0.4                  | 6.6%                     | 3.5                  | 0.6%                     | 6.5                  | 0.6%                     | 9.5                  | 0.2%                     | 12.5                   | 0.1%                     |
| 0.5                  | 5.7%                     | 3.6                  | 0.7%                     | 6.6                  | 0.6%                     | 9.6                  | 0.2%                     | 12.6                   | 0.1%                     |
| 0.6                  | 4.9%                     | 3.7                  | 0.7%                     | 6.7                  | 0.6%                     | 9.7                  | 0.2%                     | 12.7                   | 0.1%                     |
| 0.7                  | 4.3%                     | 3.8                  | 0.7%                     | 6.8                  | 0.6%                     | 9.8                  | 0.2%                     | 12.8                   | 0.1%                     |
| 0.8                  | 3.7%                     | 3.9                  | 0.7%                     | 6.9                  | 0.6%                     | 9.9                  | 0.2%                     | 12.9                   | 0.1%                     |
| 0.9                  | 3.2%                     | 4.0                  | 0.7%                     | 7.0                  | 0.6%                     | 10.0                 | 0.2%                     | 13.0                   | 0.1%                     |
| 1.0                  | 2.7%                     | 4.1                  | 0.7%                     | 7.1                  | 0.6%                     | 10.1                 | 0.2%                     | 13.1                   | 0.1%                     |
| 1.1                  | 2.4%                     | 4.2                  | 0.7%                     | 7.2                  | 0.5%                     | 10.2                 | 0.2%                     | 13.2                   | 0.2%                     |
| 1.2                  | 2.0%                     | 4.3                  | 0.7%                     | 7.3                  | 0.5%                     | 10.3                 | 0.1%                     | 13.3                   | 0.2%                     |
| 1.3                  | 1.7%                     | 4.4                  | 0.8%                     | 7.4                  | 0.5%                     | 10.4                 | 0.1%                     | 13.4                   | 0.2%                     |
| 1.4                  | 1.4%                     | 4.5                  | 0.8%                     | 7.5                  | 0.5%                     | 10.5                 | 0.1%                     | 13.5                   | 0.2%                     |
| 1.5                  | 1.2%                     | 4.6                  | 0.8%                     | 7.6                  | 0.5%                     | 10.6                 | 0.1%                     | 13.6                   | 0.2%                     |
| 1.6                  | 1.0%                     | 4.7                  | 0.8%                     | 7.7                  | 0.5%                     | 10.7                 | 0.1%                     | 13.7                   | 0.2%                     |
| 1.7                  | 0.8%                     | 4.8                  | 0.8%                     | 7.8                  | 0.5%                     | 10.8                 | 0.1%                     | 13.8                   | 0.2%                     |
| 1.8                  | 0.6%                     | 4.9                  | 0.8%                     | 7.9                  | 0.5%                     | 10.9                 | 0.1%                     | 13.9                   | 0.2%                     |
| 1.9                  | 0.5%                     | 5.0                  | 0.8%                     | 8.0                  | 0.4%                     | 11.0                 | 0.1%                     | 14.0                   | 0.2%                     |
| 2.0                  | 0.3%                     | 5.1                  | 0.7%                     | 8.1                  | 0.4%                     | 11.1                 | 0.1%                     | 14.1                   | 0.2%                     |
| 2.1                  | 0.2%                     | 5.2                  | 0.7%                     | 8.2                  | 0.4%                     | 11.2                 | 0.0%                     | 14.2                   | 0.2%                     |
| 2.2                  | 0.1%                     | 5.3                  | 0.7%                     | 8.3                  | 0.4%                     | 11.3                 | 0.0%                     | 14.3                   | 0.2%                     |
| 2.3                  | 0.0%                     | 5.4                  | 0.7%                     | 8.4                  | 0.4%                     | 11.4                 | 0.0%                     | 14.4                   | 0.2%                     |

PLC Implementation as a Flow Computer for Calculation of Saturated Steam Mass Meetings with the Linear Divided Regression Method. (Dedi)
5. CONCLUSION
The mass density calculation method of saturated steam with PLC applications using a linear regression approach can be used as an alternative flow computer that is widely used today with the best accuracy of about 0.2% in this study. The saturated vapor mass density calculation method which is divided into 5 ranges of values has a better error value which is an average of 0.2% compared to those not divided into a range of values that have an average error of 0.9%. The use of PLC is good enough to do computational flow according to the formula programmed into PLC memory.

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