DEVELOPMENT OF AN APPLICATION TO CALCULATE THE MANOMETRIC HEIGHT OF THE PUMP (MADE IN PYTHON)

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Abstract: *There are several concerns about the total head (AMT) of hydraulic pumps in hydraulic system projects. The pipe length and diameter, flow, discharge height, suction height, and load loss factor may be considered. Plenty of information often leaves the user confused in their choice of ideal equipment. So, this work proposes to develop an algorithm in Python to facilitate the option of the most suitable equipment for your needs, based on a commercial catalog of pumps. The code increases the quality and productivity of its users and decreases the time spent on calculations, maximizing company profits.*

Keywords: Hydraulic pumps; Python; Total Manometric Height.

DESENVOLVIDO EM PYTHON PARA CÁLCULO DA ALTURA MANOMÉTRICA TOTAL DE BOMBAS COMERCIAIS

Resumo: No campo dos projetos de sistemas hidráulicos existe uma série de preocupações quando tratada a altura manométrica total (AMT) de bombas hidráulicas, diversos fatores devem ser levados em consideração, tais como comprimento e diâmetro da tubulação, vazão, altura de recalque, altura de sucção e fator de perda de carga, essa quantidade de informação muitas vezes deixa o usuário confuso em sua escolha para um equipamento ideal. Tendo em vista essa dificuldade, esse trabalho se propõe a desenvolver um algoritmo em Python a fim de facilitar a escolha do equipamento mais adequado a sua necessidade, com base em catálogo comercial de bombas. O código aumentar a qualidade e produtividade de seus usuários e diminuir o tempo gasto com cálculos, maximizando os lucros de empresas.

Palavras-chave: Altura Manométrica Total; Bombas Hidráulicas; Python.

1. INTRODUCTION

When choosing a hydraulic pump for use, whether residential or industrial, many users take considerable time to carry out the necessary calculations that give them subsidy to choose the ideal equipment and when the user is not familiar with the subject, this time can be much longer or simply for lack of knowledge, purchase a non-viable pump for your need.

With the advancement of technology, globalization, and the current pandemic situation that the world is in, the use of digital technologies is increasingly gaining ground in projects that aim to improve human life, programming languages that integrate libraries with large functions and rather flashy graphic layouts are increasingly used. The Python language is one of the most popular ones, for its ease of programming and integration with many Applications Programming Interface - API.

According to Çengel and Cimbala (2007) [1], the fluid in a typical piping system flows through various connections, valves, bends, elbows, three, inlets, outlets, extensions, and reductions, in addition to the tubes. These elements interrupt the smooth flow of fluid and generate pressure drops. If the load drop of an installation is not properly verified, it can result in an incorrect sizing.

This article aims to present a proposal for the development of a code named "Hydraulic Calculator", in Python language, in the Google Colab environment, to calculate the sizing of pumps for residential hydraulic installations. norm ABNT NBR 5626 [2], which systematizes ways of dimensioning cold-water installations so that they can ensure continuous water supply, preserve its potability, guarantee maximum comfort to customers and durability of the installations.

For Kirner and Siscoutto (2017) [3], after a long period of time in which man had to adjust the possible forms of representation with the technologies at his time of creation, to find ways to make the results of the technology fit the people's needs is a behavior compatible with current Software Engineering. Taking this into account, the optimization of calculations and processes comes into consensus with this thought as it meets the need for a society that increasingly connects time to money.

Womack, Jones and Roos (1992) [4] defended in the book “The Machine that Changed the World” studies they carried out in the production processes of various organizations from the most diverse areas at the time. The data from this survey were the basis for what is currently understood as lean production.

Lean thinking, in its essence, seeks to identify and eliminate all waste in the production chain, concentrating efforts on activities that create value for the customer, which includes the search for continuous improvement, continuously removing waste, which includes time of waiting.

According to Silva Filho (2012) [5], usability is an attribute of the quality of an artifact that indicates the degree of ease and efficiency with which users perform their activities and/or express satisfaction in using the artifact. This directly impacts a user's productivity. In this way, an activity that can be performed more easily in less time than necessary is usually directly related to a user's usability and productivity.

In this context, a survey was carried out with some companies in the pump sizing industry to find out the average time needed to calculate the head of a residential pump, the impact that the faster speed of this calculation influences on customer satisfaction and whether a faster calculation would increase the company's productivity.

1.1. Algorithm

The Python language is a programming language that has no specific purpose, this implies that it does not have a defined task that the tool must supply, thus, its application is comprehensive. This means that unlike other programming languages such as HTML, which is aimed at building web pages, Python has a greater versatility of applications, so it can be used for scientific, commercial, and business purposes, such as case of this article.

Python has simple and easy-to-use syntax, object-oriented support, and efficient arithmetic with multidimensional arrays [Sala et.al. 2008] [6], which makes it easy to learn compared to other programming languages, which makes its use an interesting choice for programmers. Allied with the use of Google Collaborator (Colab), a free tool developed by Google allows anyone to write and execute arbitrary Python code through the browser, not being necessary to download any program to run the codes and promoting greater ease of data sharing, justifying your choice in this project.

1.2. Residential Pump Sizing

Considering a well for the water supply of a residential water tank, it is necessary to understand some concepts to size the motor pump that will transport this fluid, such as:

Suction height (AS): unevenness that represents the difference in height that exists between the surface of the water from the well to the pump.

Discharge height (AR): unevenness that represents the difference in height between the pump and the highest point of the installation (water box).

Total length of the pipe: distance covered by water between the well between the water distribution and the water tank.

Flow (Q): amount of water that will be pumped to the water tank, given in m³/h.

Pressure loss (PC): friction of water along the piping. In this case, the head loss will be calculated as the total length of the pipe multiplied by the head loss factor (%) which is found in manufacturers' catalogs, it being necessary to know in advance the flow, the type of pipe and its diameter.

The centrifugal pump is a product of the subclass of turbo absorption machines, whose main function is to transport fluids, through the conversion of kinetic energy from rotation to hydrodynamic energy, which will pump the liquid. Considering a residential centrifugal pump, it is possible to dimension it from the following equations:

$$Q = V/T \qquad V \rightarrow volume\ (m^3)\ |\ T \rightarrow time\ (h) \tag{1}$$

$$PC = CT\ x\ Fpc\% \tag{2}$$

$$AMT = (AS + AR + PC) + 5\% \tag{3}$$

From equation (1) it is possible to find the head loss in equation (2) and, applying the concepts mentioned above and the 5% safety factor in equation 3, it is finally possible to find the total head (AMT, given in feet/inches water gauge – W.G.) that represents the pressure required to transport the requested volume to the water tank.

2. METHODOLOGY

In view of the accentuated problem with and the emergence of the pandemic in the country, a mobile Application was developed to facilitate the choice of an ideal hydraulic pump, even though it is not aware of the mathematical calculations necessary for this purpose and without the need to initially appear in a physical store. This study was developed as a case study in the discipline of Transport Phenomena 1 at the Federal University of Bahia, taught in the first semester of 2021 by teacher Michell Thompson.

The case study was carried out with the development of a questionnaire applied to some companies in the sector located in the city of Salvador/BA and later tested with the employees of the interviewed stores.

3. RESULTS AND DISCUSSION

As per the sketch of the user interface (figure 1), to obtain the pump head (AMT), the program will request the tank capacity in liters and the total time in hours needed to fill the tank. This last data will be stipulated by the operator and from that the program calculates the flow. Then the operator must inform the suction height and discharge height, which are defined in the legend to facilitate the understanding of these quantities, the length of the pipe and based on the flow, which will be approximated to one decimal place, and the diameter of the chosen pipe by the operator among those listed, the program will associate a load loss factor, tabulated in the code itself. Finally, with all these data in hand, the AMT calculation is made considering a 5% margin for the connections used and this value is printed on the screen for the operator to have access.

Figure 1. application interface

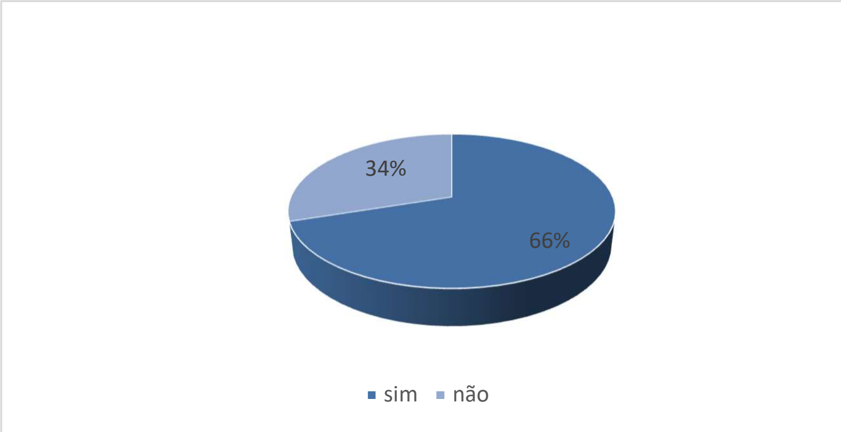
As a result of the survey carried out with some companies in the pump dimensioning field, the following questions were asked:

1) On a scale of 1 to 10 how much do you think a faster AMT calculation increases the quality of the customer experience?

2) How much time do you spend calculating AMT in your company?

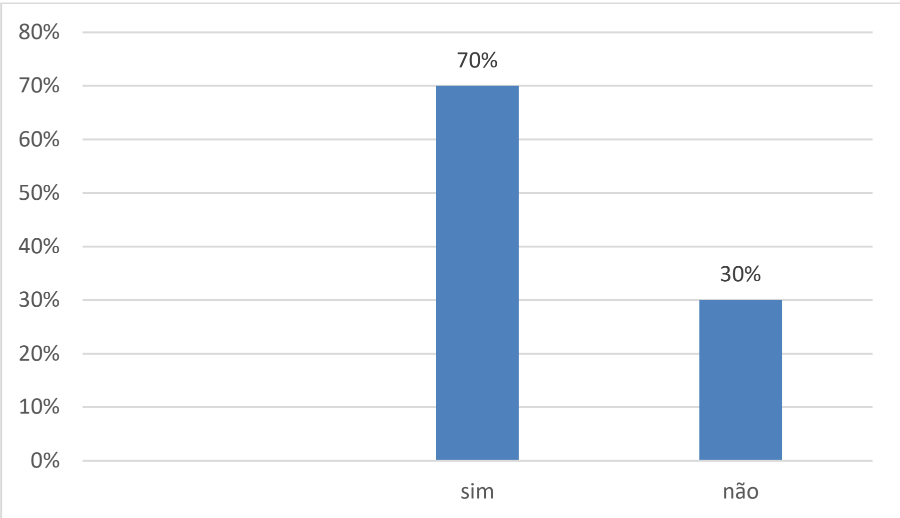
3) Do you believe that a faster AMT calculation would increase the company's productivity?

Graphic 1 - influence on the quality of the customer experience



About 66% of those who participated in the survey said that a faster AMT calculation would influence it with a score of 10 on the quality of customer experience scale.

Graphic 2 - average time spent calculating AMT less than 10 minutes



70% of respondents stated that the average time taken to perform the AMT calculation was equal to or less than 10 minutes.

4. CONCLUSION

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The HYDRAULIC CALCULATOR program was developed by Python on Google Collaborator, since it allows for greater ease in sharing codes, being free of charge, and because Python is a more intuitive language. The program was conceived thinking about its application in the professional-technical context, encouraging professionals to apply it in the sizing calculations of hydraulic systems, so they can do them in a faster and more optimized way. It can have a positive impact on the customer experience and on the company's productivity, meeting the Lean concepts of continuous improvement and waste elimination, by doing in 15 seconds what would take 10 minutes on average.

In this context, it also agrees with the concept of usability, since it increases the degree of ease of the process carried out, thus increasing the degree of productivity of the company. In addition to also influencing the customer experience since a service performed in less time with greater efficiency leads to greater satisfaction with the service provided.

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