ISSN (Online) : 2455 - 3662
SJIF Impact Factor :4.924

EPRA International Journal of
Multidisciplinary Research

Monthly Peer Reviewed & Indexed
International Online Journal

Volume: 4 Issue:7 July 2018

Published By :
EPRA Journals

Volume: 4 | Issue: 7 | July 2018 SJIF Impact Factor: 4.924 ISSN (Online): 2455-3662

EPRA International Journal of
Multidisciplinary Research (IJMR)

SHORT STORIES AS A MEAN TO TEACH CHEMICAL ENGINEERING

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ABSTRACT
To achieve the best assimilation of knowledge, professors can use many techniques when teaching the subject Unit Operations in Chemical Engineering. This article shows that the use of short stories for the resolution of problems may work as one of them.

KEY WORDS: *Engineering, Chemistry, education, short stories, problem-solving.*

I.- INTRODUCTION

Chemical Engineering is defined as:

"…the profession in which a knowledge of the mathematical and natural sciences, gained by study, experience, and practice, is applied with judgement to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind" [1]

As it can be seen from the above definition , the teaching of Chemical Engineering is based primarily on Mathematics, Physics, Chemistry and Engineering techniques that have been developed through experimentation, practice and experience for more than 100 years since the profession exists.

Nowadays, professors of Chemical Engineering at the University rely on the intensive use of sophisticated tools like computing resources, Internet and audiovisual means, to approach the resolution of algorithms and problems, etc.

However, the authors of this article have also explored the use of literature to encourage learning by using short stories in which problems related to the Unit Operations are solved.

According to the author's experience, this method is appealing to students who are afraid of deductions, calculations and other procedures commonly used by professors to lead to the resolution of problems. By way of example the author presents a short story related with a subject called Fluids Engineering.

2.- PRESENTATION

The pop quiz

Armando Gonzalez, our Fluids Engineering professor, loves pop quizzes. He told us that this kind of quizzes helps students to become more alert, aware and skilled for the professional life, which is full of surprises. For that reason, today, just after unpacking his things he told us:

"Engineers, today we are getting a pop quiz!", and immediately he handled to us several work sheets. One had written the problem statement; another was a sheet of squared paper and the other two were white sheets to perform the calculations.

Once the material was delivered to each of us, he told us:

"The first thing you have to do is to write down your name in the sheets I just gave to you. I don't want any anonymous quizzes. Second, I advise you to devote five minutes to read the statement and try to understand what I am asking you before doing any calculations. Third, only the use of calculators is allowed, you can´t work with your computers, laptops or i-phones. Fourth, use the squared paper for your diagrams. And fifth, you can consult your notes and the assigned textbook. You only have one hour and forty-five minutes to finish your quiz. So, begin!

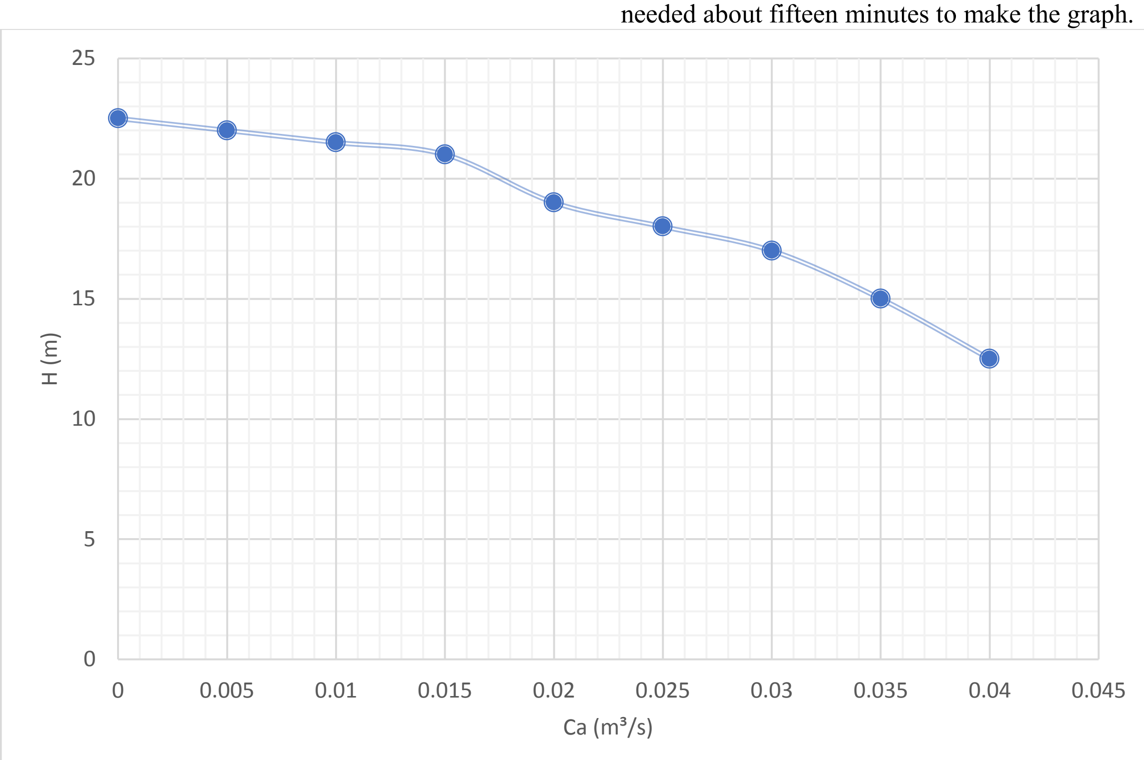
When the professor stopped speaking, we all started analyzing the problem statement, which read as follows:

A pump operating at 7500 RPM has an operation curve given by:

Flow rate in m3/s	*0*	*0.005*	*0.01*	*0.015*	*0.02*	*0.025*	*0.03*	*0.035*	*0.04*
Head in m	*22.5*	*22*	*21.5*	*21*	*19*	*18*	*17*	*15*	*12.5*

The pump drives water at 20° C through a system that has a 5-inch galvanized steel pipe, schedule 40, which is 550 m long, including attachments. The height between the entrance and exit points of the system is 12 m. The pressure on the beginning and ending points of the system is the same. Get the operation point of the pump.

I read and reread the problem. I don't know if it took me the five minutes that the professor suggested, but the only thing that came into my mind after reading the statement was using the squared paper to trace the pump's curve. I had to draw the axis carefully so that they didn't get off the limits of the sheet or remained very short. I needed about fifteen minutes to make the graph.



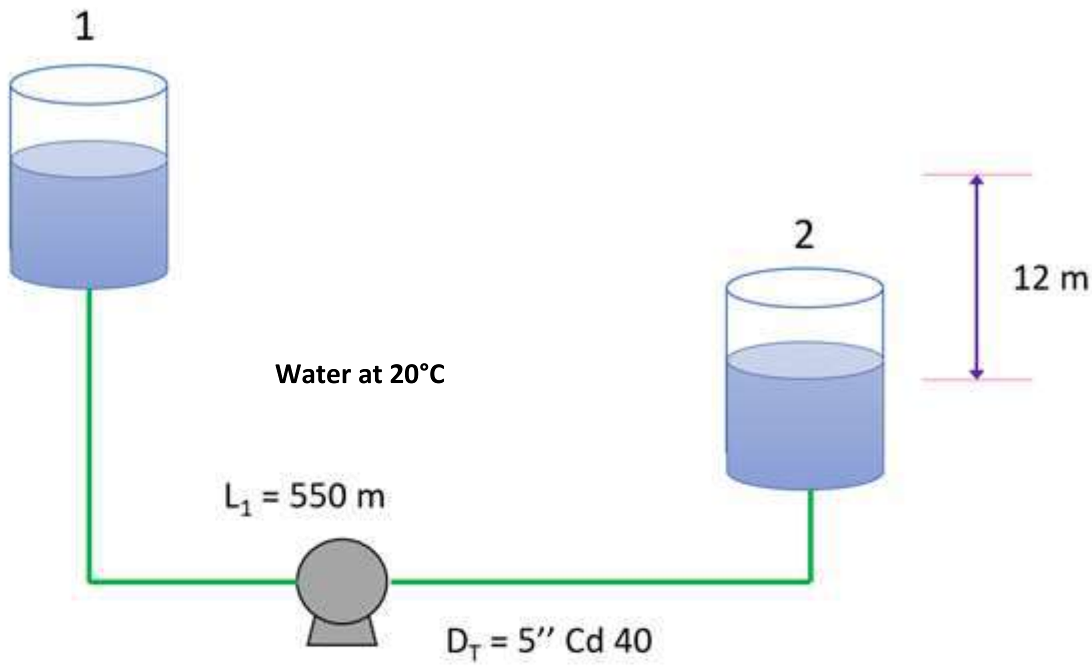
After making the graphics, I decided to evaluate certain properties of the system to soothe myself. For the water at 20 ° C, I found that [2]:

$$\mu = 1.005\ cp\mu s\ \ , \rho = 998\frac{kg}{m^3}$$

On the other hand, the pipe had a diameter of:

D= 0.12819 m, and a relative roughness of $\frac{\epsilon}{D} = 0.001$

After that , I made a drawing to represent the system, which allowed me to write the Bernoulli's equation.



$$\Delta Z\frac{g}{gc}+\frac{\Delta u^2}{2gc}+\frac{\Delta P}{\rho}+\frac{\sum F}{M}=\frac{W}{M}$$

In this equation the kinetic energy term and the pressure term were null. Therefore the equation was reduced to:

$$\Delta Z\frac{g}{gc}+\frac{\sum F}{M}=\frac{W}{M}=H$$

The term of friction losses can be evaluated by the Darcy equation [3]:

$$\frac{\sum F}{M}=f_D\frac{u^2(L+Le)}{2gcD}=f_D\frac{8Ca^2}{gcD^5\,\pi^2}$$

The problem was that the term f_D, or the friction factor, was a function of a Reynold´s number and the roughness of the material and making that calculation would be too time consuming. What were my classmates doing? I turned over and casted an eye over them. All looked pretty concerned and were engrossed in their quizzes. No one seemed to have found the answer. I had to calm myself down. The professor, dressed as always in a black suit with a white shirt, a red silk tie and a pair of thoroughly polished black shoes, walked back and forth like a lion in cage, observing us all attentively. Suddenly I sensed that he was looking at me, so I stopped peeking behind my shoulder and turned back to focus on the problem. I read the statement once more and after doing so everything became clearer to me. I was, as they say, enlightened. I remembered that the system carried water and that there were correlations that would make much easier the calculation process to obtain the friction losses for that substance.

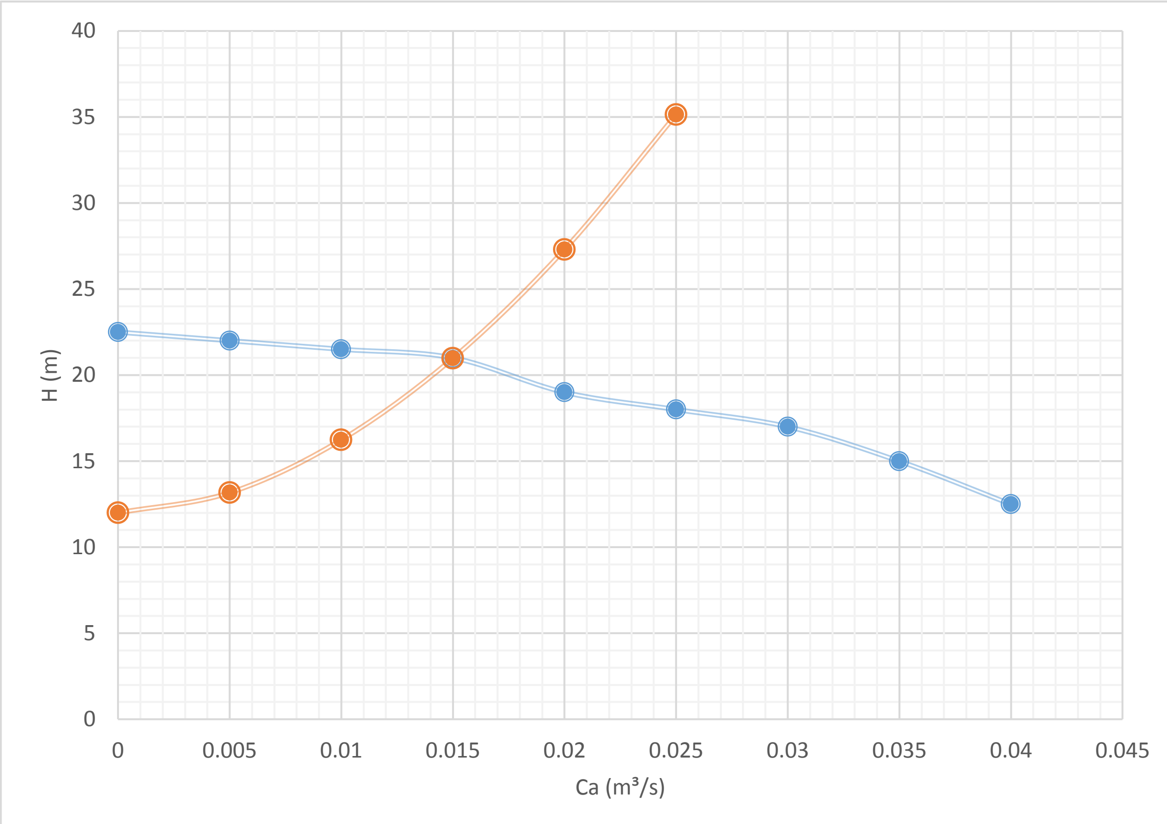
$$\frac{\sum F}{M}=10.643C^{-1.852}\frac{Ca^{1.852}}{D^{4.87}}\times(L+Le)$$

In this equation, attributed to Hazen and Williams [3,4], C is a constant which is given by the kind of material you are using, in this case C = 110. [3]
With this equation I didn't have to do so many calculations as the curve of the system was:

$$H=12+10.643\times110^{-1.852}\frac{Ca^{1.852}}{0.12819^{4.87}}\times550$$
$$H=12+21452Ca^{1.852}$$

CA in m3/s	0	0.005	0.01	0.015	0.02	0.025
H in m	12	13.17	16.24	20.98	27.3	35.14

I turned again to peep at my colleagues. They were flushed and it looked like they were about to have smoke coming out of their ears. They must have been doing many more calculations than usual, and without their lap-tops, they could not use EXCEL to make their lives easier. Above all, *Mario,* the brainy of the class, looked very concentrated. On the other hand, *El Indio,* who was sitting four benches away from me, remained with his eyes fixed on the roof of the hallway. *El Barbas* wasn't doing better; he had his eyes closed as if he was sleeping… and probably he was actually asleep. I felt again the weight of the professor's stern stare, and focused again on my job. The next step was to plot the data from the system on the chart containing the pump curve. There was the system operation point.



When I reviewed my chart, I found out that the point of intersection of the two curves, or the pump operation point, had a head of 21 m and a flow rate of 0.015 m^3s.

I revised what I did for a second time. It´s easy to make mistakes in these kind of calculations, but I didn't find any this time. So, with renewed confidence, I wrote my name on the paper sheets and folded them. I got up to finally handle the quiz to the professor. I was the first one to finish. Mario, *The Nerd,* was still working on his quiz. Professor Gonzalez gave me one of his rare smiles and said:

—"I hope you did it well"

—"So do I" —I replied and then said.— "Bye, professor".

—"I´ll see you in the next class. Remember to be ready for a new pop quiz!"

3.- CONCLUSIONS

There are numerous techniques that teachers use to attract students attention in Chemical Engineering classes. This article shows a technique based on the resolution of problems through short stories. After employing this technique over several semesters at the University, the authors believe that this procedure improves learning by making it more attractive and fun to students.

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