VIRTUAL INSTRUMENTATION LABORATORY FOR THE SIMULATION AND THE OPTIMISATION OF THE NON-NEWTONIAN FLUIDS FLOW PROCESS

Alexandru Rădulescu¹, Paul Ioanid², Irina Rădulescu²

¹ University “POLITEHNICA” Bucharest, România, ² S.C. I.C.T.C.M. S.A. Bucharest, Romania
sandu@meca.omtr.pub.ro

ABSTRACT

The purpose of this paper is to present the way to realise a virtual instrumentation laboratory for the simulation and the optimisation of the non-Newtonian fluids flow process. In a modern way and for easier and faster obtaining of the information, we offer the possibility to realise this virtual instrumentation laboratory for the simulation and the optimisation of the non-Newtonian fluids flow process. We use the ANSYS and the LabVIEW facilities, which are the most modern software in this field. That way leads to the competitiveness rise for both plans - internal and external - for the specific products, which is based on the flow process typical for the non-Newtonian fluids.

KEYWORDS: virtual instrumentation, non-Newtonian fluid, simulation.

1. INTRODUCTION

Beginning from the last decade of the XX century, in USA, Great Britain, Japan, China and other powerful states, the initiation of some prodigious universities, there were born a few parallel calculus centres, which included virtual laboratories. Their principal purpose was the high performance technology transfer in the industrial and commercial field. Those centres were born inside some universities departments or as independent units of them, such as [1, 2, 3]:

- Virtual Laboratory for Technology, University of California, San Diego
- The Virtual Chemists, Univ. of Oxford, Great Britain
- High Performance Computing Virtual Laboratory, Queen's University Kingston, Ontario, Canada
- Rice Virtual Lab in Statistics, Canadian Mathematical Society
- Virtual Engineering/Science Laboratory, Johns Hopkins University
- NTNU Virtual Physics Laboratory, Taiwan, China

Each centre had an independent evolution, developing his structure and adapting his work to the industrial partners challenges and to his own strategy.

For example, EPCC was developed like a national centre, but also a European one, with services in the high performance calculus field. OP has been developed as a component of the computer department of university and it has been oriented to the fundamental research and to the application of this research in different projects with industrial partners.
Concomitantly with the didactic activity the high performance calculus centres have also an activity oriented through the projects realised for the industrial and commercial partners.

2. THE PURPOSE OF THE VIRTUAL LABORATORY

Internet is used today, more and more, as a work instrument. All the different reasons of it are relied to the possibility to realise, in an easy and efficient way, some natural actions, typical to the productive process: the information, the opinions expression, the collaboration between the members of a team, the productive process make-up it self, the instruction and many others.

One of the important themes for using the Web resources as a work instrument is the co-operation. Using the means offered by Internet, it becomes possible the co-operation between the persons, which belong to different organisations (which are far in space, in time and as organisation), without those persons must change their activity place or their life style. That's how are quickly made very performed specialists teams, which cooperate only for a small time, during the project.

From this point of view, the virtual instrumentation laboratory is an educational multimedia modulus for learning and exploring, fitting in a knowledge theoretical base enriched with programmable objects, on-line tests, possibilities to evaluate and to record the users performance.

The study of the fluids flow process is very important for many domains. We can specify the oil industry (carrying oil products to great distance), the extractive industry (carrying ore enriched mixtures as solutions), greasing centralised installations (surgical factories), the machine construction industry, thermal motors and vehicles etc. There is also the nuclear power stations area as a less conventional domain for the research results applying, or the

**Fig. 5 Resistance calculus structure [6].**

SPAC has the type of a public firm whose shareholders are the university and different industrial companies. ULCC has the profile of a general calculus centre wishes catering for a collegium and universities conglomerate structured as University of London.

First activity direction of these high performance calculus centres is to offer high quality informative services for the academic and research community from over the world. Figures 1…5 present some simple applications with didactic purpose used in the virtual space of the instrumentation laboratories.
biolubricating domain, concerning the human body articulations - at hip and knee.

The achievement of such a virtual laboratory will influence the research development in the distributed calculus field in Romania, being a contribution to the creation of a national research high performance calculus centre. Its functions will be in the fundamental or application research and also will include the documentation, the high level instruction and consulting for different beneficiaries.

The virtual laboratory will be a project for equipment and software achievement and also - a material, informational, methodological and knowledge resources system, with the purpose of scientific research developing. It can be developed only using the international experience and it follows a better contact between the Romanian research and education and the international values circuit.

3. THE VIRTUAL LABORATORY STRUCTURE

The virtual laboratory structure for simulation and optimisation of the non-Newtonian fluids flow process will contain the next work modulus:

- a presentation modulus of the non-Newtonian fluids lubricating theory;
- a data bank concerning the non-Newtonian fluids rheological properties, greases micrographies included;
- a demonstrative modulus for the rheological tests;
- a work modulus for the plan parallel movements simulation;
- a work modulus for the movements simulation in convergent thin spaces;
- a demonstrative modulus for the flow in discontinue areas;
- images'bank for the flow process view.

Using the ANSYS and the LabVIEW facilities is the most modern way in the field. This leads to the internal and external competitively rises for the achievement products, which are based on the non-Newtonian fluids flow process. These methods give also a high level of novelty for the methods used in the virtual laboratory achievement for simulation and optimisation non-Newtonian fluids flow process.

LabVIEW - Laboratory Virtual Instrument Engineering Workbench, is a graphical schedule medium developed by National Instruments Corporation; it is useful for:

- data acquisition, analyse and presentation;
- industrial process control and command;
- systems dynamic behaviour analyses.

Using a graphical schedule named "G" we can realise executable applications, called virtual instruments, which can be used in any field. The schedule is realised by using block diagrams, which are compiled as computer code. The components of the virtual instruments are a frontal panel (PF), which simulates the measure device mask and a block diagram (DB), which is the real executable software. The frontal panel (fig. 6) contains icons, which represent different push buttons, switches, screens and other component elements of a measurement device. On the frontal panel we can include dates and we can visualise the outside dates, thus the virtual instrument will be easy identify and understand.

The block diagram (fig. 7) is composed by interconnected icons, with the information wave transmission purpose (dates).

![Fig. 6 LabVIEW frontal panel](image1.png)

![Fig. 7 LabVIEW block diagram.](image2.png)

4. THE VIRTUAL LABORATORY METHODOLOGY AND WORK TECHNICS

As part of the virtual laboratory, we shall use some of application typical techniques, such as:

- Theoretical researches (speed and pressure distribution determination, loading force, debit and temperatures field) will be approach using FEA software;
Flow process virtual simulations will be realised using software LabVIEW facilities;

- Non-Newtonian fluids rheological parameters will be determined using extrusion rheometer and capillary tube rheometer;
- Non-Newtonian fluids microscopic structure determination will be made by electronically microscopy;
- Data bank concerning the non-Newtonian fluids rheological parameters will be structured using Microsoft Access software, from Microsoft Office;
- Images banks concerning the non-Newtonian fluids microscopic structure will be realised using the interactive facilities of the Adobe Acrobat software;
- Testing and optimisation the virtual instrumentation created will be realised using an experimental concrete data set concerning the non-Newtonian fluids flow process visualisation.

Concerning the presented modulus, in figures 8, 9 and 10 will be some examples of the virtual laboratory elements [4, 5].

Fig. 8 Shellalvania 2 microscopic structure [4].

5. CONCLUSIONS

1. The laboratory and the virtual instrumentation created are not only an equipment and software acquisition project, but they are also a material, informational, methodological and knowledge resources system, with the purpose of scientific research developing. It can be developed only using the international experience and it follows a better contact between the Romanian research and education and the international values circuit.

2. Virtual laboratory will influence the research developing in the distributed calculus domain in Romania and it will contributed to achievement of the high performance calculus research national centre. Its functions will be in the fundamental or application research and also will include the documentation, the high level instruction and consulting for different beneficiaries.

3. The viability and the virtual laboratory success are guaranteed by the novelty of the non-Newtonian fluids flow process simulation problems, those can be possible, last time, owing to achievement of specialised software from this research area.

Figure 9 Grease velocity distribution [5].

\[
\dot{\gamma} = 5.50 \text{ sec}^{-1}, \quad \lambda \dot{\gamma} = 0.82, \quad \text{Re} = 0.002^2.
\]

Fig. 10 Flow visualisation process [5].

REFERENCES


