

Application of Fluid Mechanics based on Computer Virtual Reality in Pulp and Paper Engineering

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Abstract. The key technology with fast development speed, virtual computer reality belongs to a kind of data-based fluid mechanics from the aspect of the working medium. From the perspective of fluid mechanics, this paper develops an application system of fluid mechanics based on virtual computer reality in pulp and paper engineering. The structure and characteristics of pulp and paper clarify the development direction of computational fluid mechanics in pulp and paper. Based on the application of the developed system in pulp and paper making, this paper analyzes and optimizes its structure to provide a scientific reference for the development and application of computer virtual reality fluid mechanics in pulp and paper making.

Keywords: Virtual Computer Reality; Fluid Mechanics; Pulp and Paper Making.

1. Introduction

The rapid development of computer network technology has great practical significance for promoting China's education and improving teaching levels. Fluid mechanics is a science with a long history of development and new vitality, closely related to people's daily lives and industrial production. In recent years, with China's industrial development needs, many new specialties have flourished in China, bringing new tasks to pulp and paper engineering and putting forward higher fluid mechanics requirements. As an essential method, fluid mechanics is the basis for the research and development of new equipment and processes and is an essential method from qualitative analysis to quantitative analysis of experiments. Software and hardware such as switches, twisted pairs, optical fibers, and servers are used to form a high-speed switching virtual reality network on the computer. During the research process, the technicians used fluid mechanics, combined with the real-time database, relational database, and third-party software communication database embedded in China's advanced industrial control software, to jointly complete the data analysis of pulp and paper mills from the production site to the business management process. In collection applications, thousands of data points are involved in all processes.

Furthermore, the whole system completes the online real-time monitoring and management of the production process and various data of each section of the whole plant through monitoring screens. Due to the complex structure of pulp and paper making, it is not easy to fully complete the work at all levels. Therefore, adopting a "bottom-up, step-by-step implementation" approach is necessary [1]. On this basis, researchers have only carried out tentative development and application at some functional levels. In order to reach a higher level, we must increase investment in various fields. The fluid mechanics under the virtual reality technology by computer provides a new technology for pulp and paper making. Its success mainly depends on the user's management, maintenance, and development level. Strengthening the personal ability of users is an important guarantee to ensure the standard and smooth operation of the entire system.

2. Introduction to Fluid Dynamics in Virtual Reality

The physical fields that existed successively in space, time, and time, such as the flow velocity field and the pressure field, are replaced by variable values at scattered points. CFD can be understood as the equations of fluid mechanics, including matter, momentum conservation, energy conservation equations, and numerical simulation of flow fields under controlled conditions. Researchers using

this method, the distribution laws of physical parameters such as velocity, pressure, temperature, concentration, vorticity, and volume fraction of relatively many problems in different parts of the flow field can be obtained. Then the eddy current distribution characteristics, cavitation characteristics, de-flow characteristics, etc., can be obtained district etc. Other relevant physical parameters can also obtain torque, hydraulic loss, and efficiency of rotating liquid machinery. In addition, the combination of CFD and CAD allows the optimization of the structure of the equipment [2]. The CFD method, theoretical analysis, and experimental measurement methods constitute a relatively complete system. The theoretical analysis method is adopted in this paper. The universal applicability of its conclusions and the significance of each influencing factor provide a theoretical basis for experiments and the determination of new numerical calculation models. However, on some more complex issues, in order to get a reasonable explanation, it is often necessary to abstract and simplifies from a specific point of view. In many nonlinear situations, only a tiny amount of water flow can be analyzed and requires a lot of computation, which cannot be done at the processing speed of current computers. The experimental data determined by experiments provide a reliable basis for theoretical and numerical calculations. However, due to the constraints of model size, flow field disturbance, and test accuracy, in some cases, it is not easy to obtain specific conclusions by experimental methods. See Figure 1.

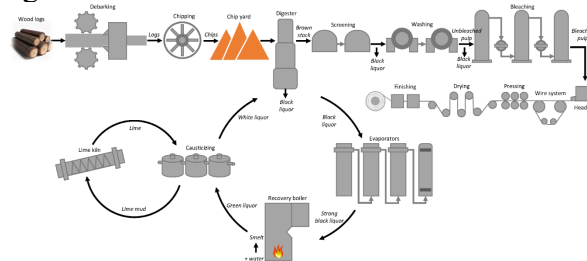


Fig 1. Whole process analysis process under pulp and paper

Nevertheless, because the experiment requires a lot of staffing, material resources, and funds, it requires a lot of energy and time. CFD can simulate a particular calculation method to achieve the purpose of testing the computer. The method can solve various large-scale instruments and complex problems, saving research costs and reducing research time.

3. Structure and Characteristics of the Pulp and Paper System based on Virtual Reality Fluid Mechanics

We all know that technical workers use block diagrams to describe a system and think in block diagrams. First, establish an equivalent model in each link, and then connect these models for analysis. Because the structure of each link is relatively simple and the parameters are small, it will not cause any interference to other connections during the setting process. This software also takes this as a starting point and designs a set of complete system structure design interfaces for users. Before using the software, the user can "draw" a block diagram that the software can recognize through the learned system structure. Since there is no need to memorize many functions, an intuitive block diagram can be used to construct the system mode, which dramatically reduces users' difficulty operating the software. On this basis, the user can "draw" a system graph in the model window using the mouse, thereby realizing the simulation of numerical simulation. It does not require users to have a high mathematical foundation, nor do they need to consider which method to use. Just enter the relevant information of the system into the system. The primary function modules of the system include the basic function module, combination module, heat balance module, and cost evaluation module. Each basic functional unit is the basis for the calculation of material balance, and each combination unit can be configured through these units; combined with modules, the functions of most devices in the pulping process are realized, and the fluid mechanic's technology of virtual reality is adopted; heat balance the module is used to measure the gas consumption of steaming and bleaching in the pulp

and paper process, and the cost estimation is to calculate the cost of each pulp and paper. Because the system has essential functions and integrated functions, which brings great convenience to users, since engineers are proficient in various instruments, it can allow novices to quickly and proficiently apply the components of this software. For high-level users, basic functional modules can be used to construct new combined components to achieve new virtual reality devices. From this point, it can be seen that the system can be extended to more user needs to some extent.

4. Development Trends of Computer Virtual Reality Fluid Mechanics in Pulp and Paper Engineering

4.1 Development of Particular Instruments and Softening Technology

In China, the special equipment for pulping and papermaking is relatively poor, which is the main factor restricting its popularization and promotion. Because of the development status of China's pulping and papermaking equipment, it is also of practical significance to use soft metering technology to estimate online parameters. To this end, in China's pulp and paper making, the development of special equipment and software testing technology provides an essential basis for further promoting and improving China's overall pulp and paper technology. See Figure 2.

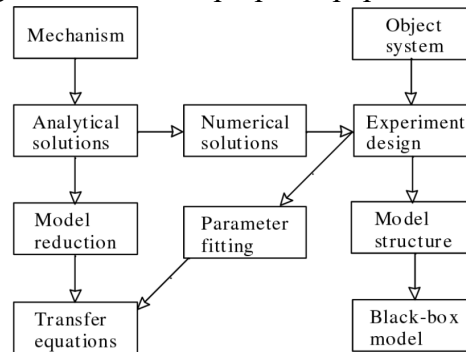


Fig 2. Virtual Computer Reality Pulp and Paper Technology Application

4.2 Discussion on Modeling and Control Strategy of Pulp Pulping and Papermaking Process

As we all know, pulp, pulp, pulp, and other multivariable, strong coupling, nonlinear, considerable time delay, substantial interference, intense time change, need to be static. In this process, it is necessary to further in-depth research and development of advanced system control methods to promote further and improve the Chinese system. The development of the overall technology of pulp and paper has laid a solid theoretical basis.

4.3 The Design of the Pulp and Paper Industry is a Computer-based Virtual Reality DCS

Using structured hardware and configuration software, the researchers standardized the models of pulping and papermaking, bleaching, beating, pulping and papermaking, evaporation, combustion, and other processes, thus forming a model library of virtual simulation DCS for the pulp and paper industry[3]; Based on the existing control methods for pulping and papermaking, a control algorithm that meets the requirements of "configuration" is developed, thereby forming a mathematical model of computer simulation DCS for pulping and papermaking.

4.4 The Core of Pulp and Paper Enterprises is the Integrated Data Inventory

Through the virtual fluid dynamics of the computer, the data is transmitted to various automatic devices, and it is effectively monitored and monitored, thus forming a complete automation system covering the design, test, and production of the enterprise. Therefore, it significantly promotes the quality of products, the utilization of equipment, the scientificity of decision-making, the rationality of management, and the automation of production.

5. Research on Computer Virtual Reality Fluid Mechanics Simulation for Pulp and Paper Making

5.1 Paper is an Essential Part of the Development History of Human Civilization, and its Application Scope has been Expanded to All Aspects of China

With the continuous development of science and technology and the continuous improvement of people's production level, the pulp and paper industry will continue to develop new technologies and new equipment for large-scale, high-speed, continuous production and automatic development to achieve better effects and energy-saving, The purpose of reducing the environment is the main work of the current Chinese pulp and paper technicians.

The pulping process comprises four stages: pulping, rectification, jetting and drying. Among them, the specific application of pulp turbulence theory in the four stages is as follows: a pulping test is carried out to improve the flow rate of pulp to ensure The average velocity of the slurry in the horizontal direction of the slurry ensures the uniformity of the slurry in the horizontal direction, and the size of the static pressure head of the slurry at the inlet end of the slurry is the same. Therefore, in engineering, this kind of pulp distribution device is called an "isobaric turbulence tube," which usually uses the same size and dense tube bundles to disperse the pulp into smaller tube bundles because of its high speed. The small volume of the tube allows the pulp to create a bit turbulent flow in the tube, a structure that disperses the fibers and unclogs the flow of the pulp. A giant vortex and uneven flow can be avoided after the typical slurry passes through the homogenizing roller. When the slurry passes through the half of the upstream side, due to the existence of the "sieve," it will play a role in deflocculating the slurry when it passes through the small holes, which creates a turbulent flow around the hole wall.

5.2 Modeling

A parameter of the e-type is improved to improve the calculation accuracy of large velocity gradients; on this basis, the vortex effect is introduced to improve the ability to solve strong swirling flows; a new numerical calculation of turbulent flow is proposed method, while in normal mode the amount of turbulence is a constant value set by the user;See Figure 3.

The k, s equations for RNGk-e mode are:

$$\frac{\partial(\rho k)}{\partial t} = \frac{\partial}{\partial x_j} \left[(\alpha_k v_{eff}) \frac{\partial k}{\partial x_j} \right] + G_k - \rho \epsilon \tag{1}$$

$$F(t) = \frac{\partial}{\partial x_j} \left[(\alpha_\epsilon v_{eff}) \frac{\partial \epsilon}{\partial x_j} \right] + G_\epsilon - \frac{\epsilon^2}{\rho} \tag{2}$$

Here is: $v_{eff} = v + v_1, \mu_1 = \rho \frac{k^2}{\epsilon}, \partial k = \partial \epsilon = 0.13$.

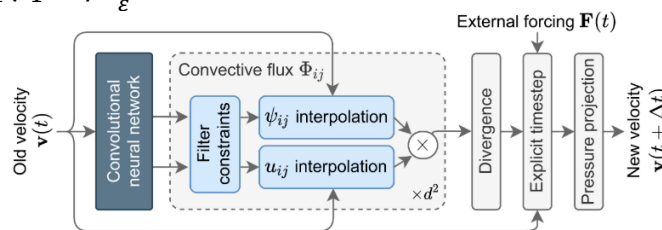


Fig 3. Numerical Computational Methods for Turbulent Flow Fluid Mechanics

This method maintains the advantages of the traditional k-s mode in accuracy and fully reflects the effect of rotation on solving significant rotation problems. On this basis, the researchers chose the RNG k – ε mode. According to the above assumptions, since the pulp is a non-compressed liquid, there is no heat transfer during motion, so its energy conservation formula can be ignored. The mathematical models of the overall flow of pulp include momentum conservation equation, pulp flow

equation, k equation, ε equation, etc. According to the above four formulas, the mathematical model of the slurry flow field required by the mechanism is established.

$$\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x_i} (\rho u_i) = 0 \tag{3}$$

$$\frac{\partial}{\partial x_j} (\rho u_i u_j) = -\frac{\partial p}{\partial x_i} + \frac{\partial}{\partial j} \left[\mu \frac{\partial u_i}{\partial x_j} + \tau_{ij} \right] \tag{4}$$

$$\frac{\partial (\rho k u_i)}{\partial x_i} = \frac{\partial}{\partial x_j} \iint \left[(\alpha_k \mu_{eff}) \frac{\partial k}{\partial x_j} \right] \tag{5}$$

$$\frac{\partial (p \varepsilon)}{\partial t} + \frac{\partial \rho k u_i}{\partial x_i} = \frac{\partial}{\partial x_j} \iint \left[(\alpha_\varepsilon \mu_{eff}) \frac{\partial \varepsilon}{\partial x_j} \right] \tag{6}$$

Among them, u_i and u_j represent the change of velocity; ρ is the concentration of the liquid, p is the pressure applied to the micro-element of the liquid, (Pa); μ is the dynamic viscosity, k is the turbulent kinetic energy, ε is the turbulent loss, and τ_{ij} is Reynolds stress.

6. Structural Analysis and Optimization of Computer Virtual Reality Fluid Mechanics in Pulp and Paper Engineering

The primary function of the uniform headbox is to spray the dispersed slurry evenly to the forming part; the better the distribution of fibers, the more uniform the paper will be.

Quantity, uniformity, and stability ensure the stability of pulping and papermaking equipment and the continuous work of subsequent processes (such as rewinding, coating, printing, etc.). The change in quantity is divided into vertical and horizontal. For paper machinery, it mainly depends on the characteristics of the headbox[4].

The primary conditions of the type head machine are: the first condition is related to the characteristics of the turbulence generator, the second condition is related to the pulping equipment and the dilution equipment, the large lateral distribution depends on the pulping equipment, and the fine adjustment mainly depends on For thinning equipment, the third aspect is to rectify the slurry, and then compress and adjust the slurry through the equipment at the mouth, to achieve the outlet slurry flow of the headbox. In addition to the above aspects, the correct use of the slurry is also critical because it is a material that is easy to entangle and bond. See Figure 4.

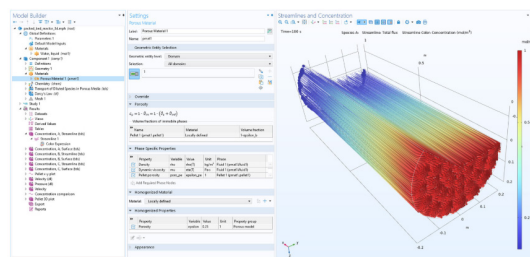


Fig 4. Computer Virtual Reality Simulation of Fluid Mechanics for Papermaking

If this happens, it is likely to cause paper damage, and in severe cases, it will lead to paper damage. Moreover, the fibers in the slurry will also cause some small holes, stains, and other problems, which is also a significant problem in the production process. In addition, the deformation of the headbox due to its structure during use is also a critical issue. In addition, it is necessary to pay attention to the problems of seals, adjustment, cleaning, etc., which should be comprehensively considered in the structural design. A little attention may lead to mistakes in engineering practice. However, the structural analysis and Design of the headbox for high-speed pulping and papermaking is a challenging problem. There is neither complete theory nor mature experience to draw on. According to the actual situation, the structure analysis is carried out, and then the simulation comparison is carried out to improve the scheme.

7. Prospects

The future development of fluid mechanics pulping and papermaking should draw on the new methods and theories of computer virtual reality fluid mechanics and closely integrate the actual needs of engineering problems. Future research needs to focus on the following aspects:

Based on the traditional research methods and achievements of pulp and paper making and integrating it with computer simulation technology, it cannot be separated from the nature and times of pulp and paper making. In addition, in this regard, it should also be undertaken by scholars who manufacture pulp and paper, especially the solution of problems and the Design of structures. In this regard, computer virtual reality technicians can provide support and guidance.

Based on machine learning and model, the big data in pulp and paper making is analyzed. Compared with the big data on the Internet, although a large amount of data will be generated during the experiments and operations of pulp and paper making, they are all obtained under certain boundary conditions, which are different from traditional high-dimensional, geometric boundaries conditions, and manufacturing[5]. Compared with the high-dimensional, cross-scale, stochastic nonlinear characteristics of pulp and paper, it is a small problem on many occasions. How to do machine learning on a small scale has always been a big problem in pulping and papermaking, and how to compare limited samples with existing conservation equations, scales, scales, and empirical models It has achieved good results in terms of structural features, model structure design, model optimization, and model optimization.

Improve the interpretability of hydraulics for pulp and paper making and explore its new physical meaning and new scientific understanding. The neural network as a typical black box and statistical machine learning algorithm has been constrained due to its shortcomings such as poor interpretability and poor stability, especially in recent years, especially in machine learning in pulp and paper making. The critical development in the future is to combine the existing knowledge of pulp making and paper making with virtual computer technology to conduct more in-depth research.

8. Conclusion

Computer virtual reality fluid mechanics provides a new research paradigm for the development of pulp and paper, and pulp and paper provide a sufficiently complex research object for the development of computer virtual reality fluid mechanics. From a new perspective, this paper systematically summarizes the research progress of hydrodynamic pulping and papermaking in recent years and briefly discusses the difficulties and development trends of hydrodynamics pulping and papermaking research. It is hoped that computer virtual reality fluid mechanics can inspire China's pulp and paper making.

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