Influence and Simulation of Pipeline in Floating Wave Power Generation System

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Abstract. With the gradual decrease of land resources, people pay more and more attention to the development of marine resources, and the use of marine wave energy has become the focus of people. In this paper, the pipeline parameters and pipeline model of the floating power generation device are set up. The comprehensive simulation of the hydraulic system is established by AMESim software. Under the condition of ensuring the normal results of the simulation model, the simulation model is solved by the solver to obtain the pressure fluctuation in the pipeline. The influence of inner diameter and length of pipeline on pressure fluctuation is analyzed. At the same time, through the feedback of pipeline pressure and the actual situation analysis, the feasible suggestions are given, which has certain reference significance for the design of hydraulic pipeline and provides theoretical support for the actual large wave power generation.

1. Introduction
As people pay more and more attention to the development of marine resources, wave energy power generation has also attracted much attention. With the improvement of people’s technological progress and efficiency, float power generation has also been accepted [1–2]. The float on the sea is used to oscillate up and down with the wave, and the generator power generation is driven by the mechanical hydraulic transmission system [3]. In this, the mechanical way to collect transmission wave energy is gradually replaced by hydraulic power transmission because of transmission efficiency and maintenance difficulties. Hydraulic transmission has the advantages of large power volume ratio, easy to use and stable system. The hydraulic transmission also needs to be adjusted and improved, among which the construction of pipelines is the most important. If the traditional calculation is used to adjust the parameters, a lot of manpower and material resources will be wasted, and the number of experiments will not be successful. Using AMESim software for simulation can greatly save time. For AMESim, it has enough powerful and rich mechanical hydraulic library to support the completion of pipeline experiments, which is freed from tedious calculations [4-5].

2. Hydraulic system modeling
The AMESim sketch model is built, and the system is simulated by using a wealth of mechanical library, hydraulic library, signal library and hydraulic design library. The model is shown in Figure 1 as follows:
3. Selection of pipeline sub-model
AMESim has many sub-models in the hydraulic pipeline, among which Compressibility (C volume), the fluid phenomenon in the pipeline 3, is used to calculate the pressure; Friction (R resistance) is used to calculate pressure loss along the way; Inertia (I inertia) for calculating wave effects. Theoretically, the more complex the pipeline model is, the more accurate the simulation results will be. However, the complex pipeline model may not adapt to other models, which may lead to the conflict of sub-models and the deviation of calculation, and even lead to the inability to run the simulation. Therefore, we should choose the required sub-models according to the actual situation [6-7].

Usually, the pipe’s sub-model uses the ‘lumped’ sub-model to achieve satisfactory results, in which attributes such as pressure are represented by a value. In other words, in the pipeline we assume that the pressure varies little with the position. But if the pipeline is long or the wave dynamics is obvious, the ‘lumped distribution’ submodel is used. For this model, quantities such as pressure are calculated from a series of positions. Usually these values are saved as an array. The following models are obtained by solving the continuity and momentum of the 1-D Navier-Stoke equation:

\[
\frac{\partial \rho}{\partial t} + \frac{\partial (\rho u)}{\partial x} = 0
\]  
\[
\frac{\partial (\rho u)}{\partial t} + \frac{\partial (\rho u^2 + p)}{\partial x} + \eta_{\text{friction}} = 0
\]

Medium \( \rho \) - density  
\( u \) - Speed in pipes  
\( \eta_{\text{friction}} \) - Friction force

In 'lumped distribution', these equations can be simplified as ordinary differential equations to model the pipeline, which are integrated over time in AMESim solver [8].

4. Simulation results and experimental analysis
As shown in Figure, the speed of the generator is stable and the system runs stably under the action of the integrated system with the accumulator. Subsequently, we begin to study the influence of the pipeline on the overall system under different parameters.
4.1. Influence of pipeline diameter on system

For the inner diameter of the pipe, the parameters of the two pipes are designed as shown in table 1, table 2.

**Table 1. Ameter Adjustment for Pipe 2**

| Scheme | pipe 1 Width | pipe 2 Width |
|--------|--------------|--------------|
| scheme 1 | 25           | 25           |
| scheme 2 | 25           | 30           |
| scheme 3 | 25           | 35           |
| scheme 4 | 25           | 40           |

**Table 2. Ameter Adjustment for Pipe 1**

| Scheme | pipe 1 Width | pipe 2 Width |
|--------|--------------|--------------|
| scheme 1 | 25           | 25           |
| scheme 2 | 30           | 25           |
| scheme 3 | 35           | 25           |
| scheme 4 | 40           | 25           |

The influence of different parameters of pipeline 1 and pipeline 2 on their respective pipelines can be seen through calculation and simulation. In order to be practical, the length of pipeline 2 is longer than that of pipeline 1.
By observing the pipeline pressure fluctuation curves of figure 4, the fluctuation range of the pipeline is obvious from the beginning to about 0.6 s, and then the fluctuation of the pipeline tends to be gentle. At the same time, it can be seen that the inner diameter of the pipeline has little effect on the fluctuation of pipeline 1.

![Figure 4. Effect of inner diameter of pipeline 2 on pressure fluctuation](image)

It can be seen from Figure 4 that in the case of insufficient length of the pipeline, the small range change of the inner diameter has little effect on the pressure fluctuation in the pipeline, and the main influencing factor is in the pipeline 2 with enough length. It can be clearly seen from the figure that the fluctuation of the pipeline decreases with the increase of the inner diameter. So here we ignore the influence of pipe diameter on pipe 1.

### 4.2 Effect of pipe length on the system

Under the condition of keeping the total length of the pipeline unchanged, the parameters of pipeline 1 and pipeline 2 are adjusted. Because pipeline 2 needs to transmit link generators, the required length is longer than other pipelines. At the same time, in order to pursue the authenticity of the simulation and the accuracy of the experimental results, it is stipulated that the sum of the lengths of pipeline 1 and pipeline 2 is a constant [9-10], as shown in Table 3.

| Scheme  | Length Design of Pipe 1 and Pipe 2 |
|---------|-----------------------------------|
| Scheme 1| 120 90 60 30                        |
| Scheme 2| 136 166 196 226                     |

Because of the parameter setting, the change of fluctuation needs to adjust the simulation time and printing interval, and the comparison results of pipeline 2 ports under different parameters are shown in Fig. 5.
It can be clearly seen from Figure 8 that the influence of different parameters on the pipeline 2. The maximum wave peak in the four curves is 42.3 bar of the original scheme, and the minimum is 27.6 bar of the scheme 2. That is to say, the parameters of the scheme 2 are reduced by 34.7 % compared with the original scheme. At the same time, it can also be seen that the vibration amplitude of the scheme 2 is more gentle than other schemes.

5. Conclusion
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