Scholars Journal of Engineering and Technology (SJET) **ISSN 2321-435X (Online)**
Sch. J. Eng. Tech., 2014; 2(3B):436-439 **ISSN 2347-9523 (Print)**
©Scholars Academic and Scientific Publisher
(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Research Article

Calibration pipe friction coefficient for oilfield water injection system based on the adjustable parameter tree

Yinfeng Wang*[1] , Qingde Zhao[2]
School of mathematical sciences and technology, Northeast Petroleum University, Daqing 163318, China.

***Corresponding author**
Yinfeng Wang
Email: feimeng.wyf@163.com

Abstract: The oilfield water injection network had the characteristic which was the value of pipe roughness general between 0.013 and 0.018, so the method of adjustable parameter tree is proposed to calibration pipe friction coefficient, the method which makes adjusted node flow similar to given node flow by calibrating pipe roughness coefficient, could calibrate pipe friction coefficient. In this article, an idea network had been tested, and the result was preferable, so the adjusting parameter tree was effective.

Keywords: the method of adjustable parameter tree；pipe friction coefficient；oilfield water injection network

INTRODUCTION

The oilfield water injection network hydraulic model could be used for planning network,scheduling network ,the simulation operation of modification and expansion project, so the model was accurate or not directly related to fitting level of the actual pipe network hydraulic operation state, and accurate parameters could be in line with more real hydraulic model, could better simulate water supply, more accurately analyze operation, more design for the water injection network. Although pipe friction coefficient[1] had been changed for pipe scaling,the measured data showed that the value of pipe roughness[2,3] was between 0.013 and 0.018, so we could calibrate pipe friction coefficient by adjusting pipe roughness. Based on the above analysis, in this article the method of adjustable parameter tree was proposed to calibrate pipe friction coefficient, An idea network has been tested, and the results was preferable, so the tree of adjustable parameter was effective .

THE METHOD OF ADJUSTABLE PARAMETER TREE

In the oilfield water injection network, the pipe friction was the function [2,3] of the pipe roughness, when node pressure and node flow of the pipe had been known, namely

$$s_{ij} = \frac{10.29 n_{ij}^{\ 2}}{d_{ij}^{\ 5.3}} l_{ij} \qquad (1)$$

Where s_{ij} was the pipe friction coefficient between node i and j; l_{ij} was the pipe length between node i and j; d_{ij} was the pipe diameter between node i and j. And by the formula[2,3]:

$$h_{ij} = H_i - H_j = s_{ij} q_{ij}^{\ n} \qquad (2)$$

(Where h_{ij} was the head loss between node i and node j; H_i was the pressure of node i; H_j was the pressure of node j; n of the value witch was between 1.852 and 2 had been determined by the different formula). the pipe flow could been adjusted in order to change node flow by adjusting pipe friction coefficient in fixed condition of node pressure, so the pipe roughness could be adjusted in order to get different node flow until closing to known node flow, and the value of pipe roughness is the requested at this time.

In the process of above analysis, the chosen pipe called adjustable parameter pipe. In every time calculation, the whole network was decomposed into many trees, and the tree was called adjustable parameter tree [4] as shown in fig-1.

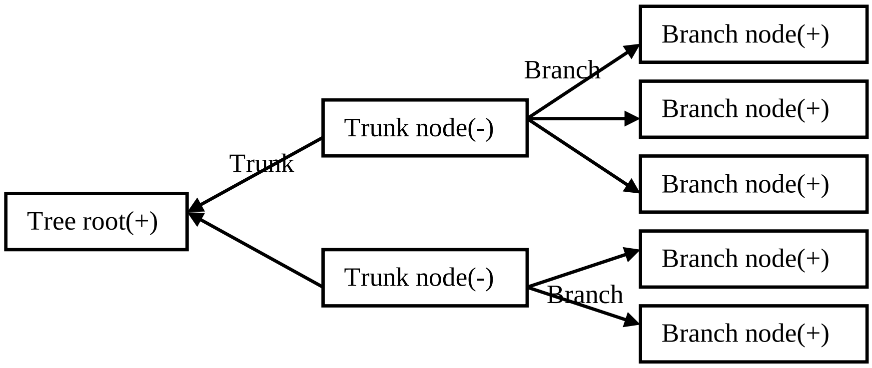

Fig-1: The adjustable parameter tree

We made the following definition:

$sub(Q_i)$: the difference between the calculated node flow and the given flow;

Positive node: the node of $sub(Q_i) > 0$;

Subtractive node: the node of $sub(Q_i) < 0$;

Zero node: the node of $sub(Q_i) = 0$;

Upstream node: the node of the water upstream;

Downstream node: the node of the water downstream;

Tree root:the node of $sub(Q_i) > 0$;

Trunk node: the upstream node of tree root;

Branch node: the downstream node of trunk node;

Trunk: the pipe between tree root and trunk node, and water flow to the tree root;

Branch:the pipe between branch node and trunk node, and water flow to the trunk node;

Because the value of n_{ij} was between 0.013 and 0.018, So at the first time, we made all pipe roughness for $n_{ij} = 0.013$, and calculated node flow and $sub(Q_i)$ at this time, then we illustrated how to determine adjustable parameter pipe,for example the adjustable parameter tree with tree root of positive node.

(1) The trunk without branches which trunk node was subtractive node, was adjustable parameter pipe, and was called 0 type trunk.

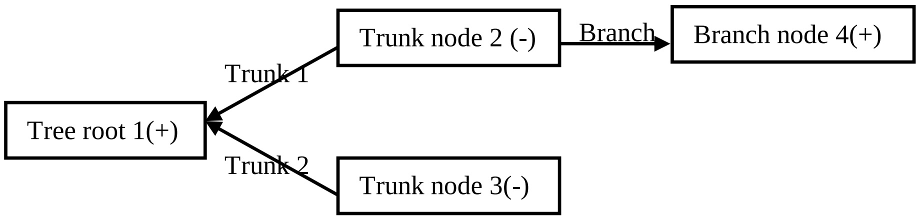

Fig-2: The adjustable parameter tree of the trunk without branches

Trunk 2 in the figure 2 was the trunk without branches. we only increased the pipe friction coefficient of trunk 2,in order to make $sub(Q_1)$ and $sub(Q_3)$ to be close to zero, so Trunk 2 was the adjustable parameter pipe.

(2) If the tree had one trunk, and trunk node was subtractive node, the only trunk was adjustable parameter pipe and called 1 type trunk.

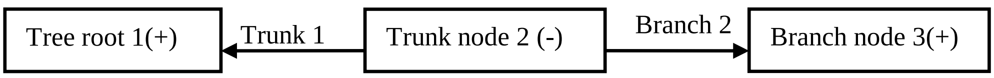

Fig-3: The adjustable parameter tree of only one trunk

In the figure 3, the adjustable parameter tree had only one trunk. Because tree root's $sub(Q_1) > 0$ and trunk node's $sub(Q_2) < 0$,we only increased the pipe friction coefficient of trunk 1,in order to make

$sub(Q_1)$ and $sub(Q_2)$ to be close to zero,so trunk 1 was the adjustable parameter pipe.

(3) If the tree had many trunks, the trunk that trunk node was subtractive node,and branch node was subtractive or zero node, was the adjustable parameter pipe and called 11 type trunk.

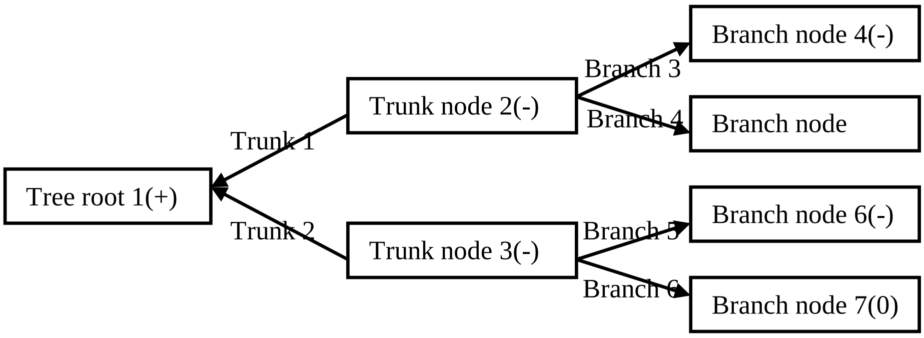

Fig-4:The adjustable parameter tree of two trunks

In the figure 4, the adjustable parameter tree had two trunks. In order to make the tree root's $sub(Q_1)$ to be close to zero, we could increase the pipe friction coefficient of trunk 1 and trunk 2,then we analyzed the feasibility of the two schemes.

Increasing the pipe friction coefficient of trunk 2. Because tree root's $sub(Q_1) > 0$ and trunk node 3's $sub(Q_3) < 0$, it could make $sub(Q_1)$ and $sub(Q_3)$ to be close to zero, so it was the only solution that increased the pipe friction coefficient of trunk 2.

Increasing the pipe friction coefficient of trunk 1. Because tree root's $sub(Q_1) > 0$ and trunk node 2's $sub(Q_2) < 0$, although it could make $sub(Q_1)$ and $sub(Q_2)$ to be close to zero, it which increased the pipe friction coefficient of branch 3 and branch 4, got the same effect, so it was not feasible.

Therefore, the adjustable parameter pipe was the trunk which the trunk node was subtractive, and the branch node was subtractive or zero node.

From the above analysis, for the adjustable parameter tree of positive tree root and subtractive trunk node, the adjustable parameter pipe was the 0 type or 1 type or 11 type trunk. The method of adjusting pipe friction coefficient was called the adjustable parameter tree, and the algorithm process was as follows.

Step 1: set all pipe roughness $n_{ij} = 0.013$,then calculate all node flow and $sub(Q_i)$ at this time;

Step 2: if the tree root satisfies $sub(Q_i)/Q_i > 3\%$, choose the adjustable parameter pipe in the adjustable parameter tree;

Step 3: if the adjustable parameter pipe of pipe roughness $n_{ij} < 0.018$,then set the pipe roughness $n_{ij} = n_{ij} + 0.001$, and calculate all node flow and $sub(Q_i)$ at this time;else turn to step 2.

Step 4: if all nodes satisfy $sub(Q_i)/Q_i < 3\%$, end algorithm; else turn to step 2.

SIMULATION EXAMPLE

In this article, the ideal network was shown in figure 5. it had 9 nodes, 12 pipes and 4 rings, the basis data of the network was shown in table 1,and the last column of table 1 was the true value of all pipe roughness.

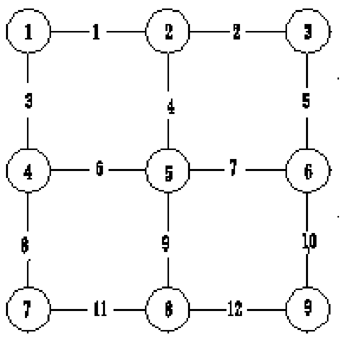

Fig-5: The ideal network

Table-1: The basis data of the ideal network

Node number	Node flow (m^3/h)	Node pressure (m)	pipe number	Upstream node	Downstream node	Pipe diameter (m)	Pipe length (m)	n_{ij}
1	-184.4	15.4	1	1	2	0.2	3000	0.013
2	-180.9	15.3	2	2	3	0.15	1800	0.014
3	-133.6	15.2	3	1	4	0.2	3000	0.014
4	-53.7	15.1	4	2	5	0.2	1000	0.013
5	30.9	15	5	3	6	0.2	1500	0.013
6	112.9	14.9	6	4	5	0.2	1200	0.015
7	-28.4	14.8	7	5	6	0.15	1500	0.013
8	231.4	14.5	8	4	7	0.15	1300	0.016
9	205.8	14.2	9	5	8	0.2	1400	0.013
			10	6	9	0.15	1500	0.015
			11	7	8	0.15	1000	0.013
			12	8	9	0.15	1000	0.013

According to the data of the figure 5, and setting node 5 for constant pressure node, the node equations were set up to get every node pressure which the value was shown the third column of the table 1.

In the beginning,set all pipe roughnesses $n_{ij} = 0.013$,and calculate all node flows, $sub(Q_i)$ and $sub(Q_i)/Q_i$ at this time. According to the above data, the ring network was translated into many adjustable parameter trees, all pipe roughnesses were adjusted by the method of the adjustable parameter tree, the calculated values were shown as the table 4. By the table 2 available: calculated values were consistent with true values, and calibration results were ideal.

Table-2: The correction value and the true value

Pipe number	1	2	3	4	5	6
True value	0.013	0.014	0.014	0.013	0.013	0.015
correction value	0.013	0.014	0.014	0.013	0.013	0.015
Pipe number	7	8	9	10	11	12
True value	0.013	0.016	0.013	0.015	0.013	0.013
correction value	0.013	0.016	0.013	0.015	0.013	0.013

CONCLUSION

In this paper, combining with the characteristics of the oilfield water injection network, the method of the adjustable parameter tree was corrected pipe friction coefficient.the method was simple and easy to implement, and quick speed to solve.for example, An ideal network was validated the algorithm which got the good results,and the result illustrated that this method was feasible.

REFERENCES

1. Zhang Tuqiao, Xu Gang, Lv Mou, Zhuo Min; Research on friction factors calibration of water distribution system. Journal of Zhejiang University(Engineering Science), 2006; 40 (7): 1201-1205.
2. Zhao Hongbin, Yan Xushi; The theory and analysis of water supply pipe network system.Bejing:China Building Industry Press, 2003; 50-53,55-57,38-152.
3. Zhong Weijun; Urban water supply system of computer operation and design. Southeast university press,1995;10-33.
4. Long Yi; Application of graph theory in sewer system plan optimization .Sichuan Southwest Jiaotong University, 2003.