Chapter 5

Discussion

5.1 A Sample Application.

To illustrate optimum design solution, a sample network layout is shown in Figure 5.1. This network consists thirty-two components that are listed in Table 5.1. The optimum piping network is designed with the following data: discharge outlet space is 200 ft; project life = 10 years; salvage value at the end of project life = 0.05 of the original material value; annual usage hours = 500; annual interest = 5%; unit power cost = 0.05 \$/hp-hr; pump & driver efficiency = 0.9; pipe roughness = 0.0002 in (Yang, Liang, and Wu, 1975).

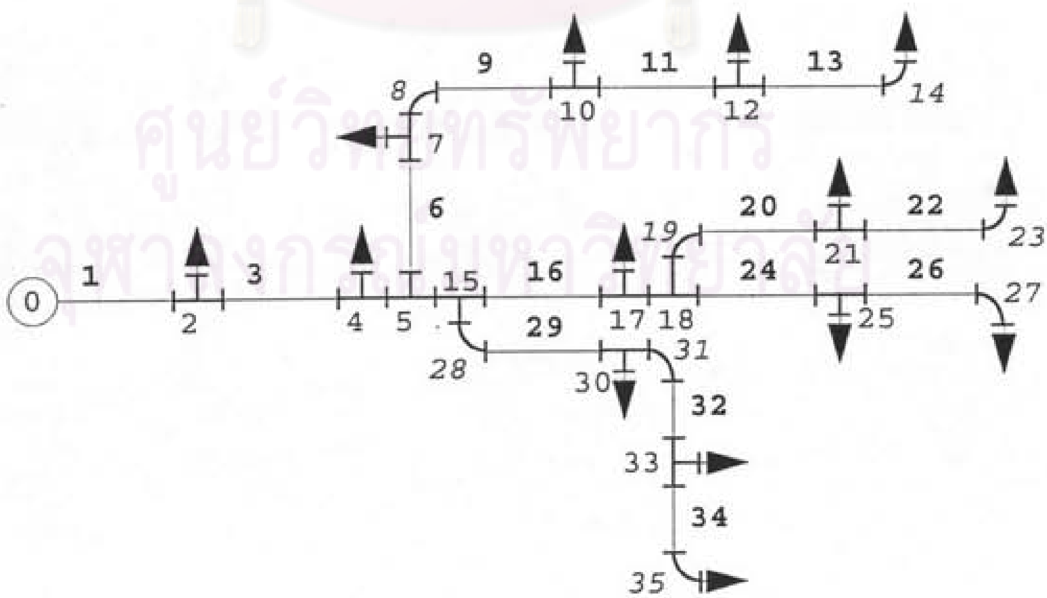

Figure 5.1: Branched network in example.

Commercial aluminum pipe data can be found in Table 5.2. Fitting cost and reducer cost are listed in Table 5.3 and Table 5.4 respectively.

Table 5.1: Network component data.

number	type	Flowrate	number	type	Flowrate
1	pipe	4.0656	19	elbow	0.5785
2	tee		20	pipe	0.5785
3	pipe	3.7656	21	tee	
4	tee		22	pipe	0.2865
5	tee		23	elbow	0.2865
6	pipe	1.1583	24	pipe	0.5778
7	tee		25	tee	
8	elbow	0.8675	26	pipe	0.2864
9	pipe	0.8675	27	elbow	0.2864
10	tee		28	elbow	0.8681
11	pipe	0.5785	29	pipe	0.8681
12	tee		30	tee	
13	pipe	0.2864	31	elbow	0.5748
14	elbow	0.2864	32	pipe	0.5748
15	tee		33	tee	
16	pipe	1.4454	34	pipe	0.2864
17	tee		35	elbow	0.2864
18	tee				

flowrate in cuft/s

Table 5.2: Cost of pipes.

Norminal Pipe Size, in	Inside Diameter, in	$ per 100 ft
2	2.067	25.30
3	3.068	38.20
4	4.026	51.10
5	5.047	68.00
6	6.065	93.70
8	7.981	154.20
10	10.020	210.50
12	12.000	285.30
15	15.000	408.70

Table 5.3: Cost of fittings.

Size, in	Tee, $	Elbow, $
2	2.18	1.54
3	3.87	1.85
4	4.12	2.24
5	4.86	3.56
6	5.38	4.13
7	6.98	5.68
8	7.74	6.35
10	9.70	8.16
12	13.85	11.98
15	21.65	16.58

Table 5.4: Cost of gradual connectors.

	Size of other end, in								
Size, in	2	3	4	5	6	8	10	12	15
2		0.64	0.77	0.94	1.19	1.80	2.36	3.22	4.48
3			0.90	1.07	1.32	1.93	2.52	3.31	4.62
4				1.20	1.46	2.07	2.73	3.48	4.71
5					1.63	2.23	2.84	3.75	4.88
6						2.49	3.06	3.89	5.04
8							3.76	4.52	5.70
10								5.06	6.25
12									7.12
15									

The results of the optimum piping network design are presented in Table 5.5. The minimum cost of this system is yielded at 421 $/year.

Table 5.5: Results of design.

number	optimum diameter, in	number	optimum diameter, in
1	10	19	6
2	10	20	5
3	10	21	5
4	10	22	3
5	10	23	3
6	6	24	5
7	6	25	5
8	6	26	3
9	5	27	3
10	5	28	10
11	5	29	5
12	5	30	5
13	3	31	5
14	3	32	5
15	10	33	5
16	6	34	3
17	6	35	5
18	6		

5.2 A Comparison of the Solution to Others.

For the comparison of the solution to other mathematical programming models, pipes of the network are only considered. Therefore, configuration of the system (Figure. 5.1) can be presented in Figure 5.2. The comparison is shown in Table 5.6. The total cost of nonlinear programming method is 451 \$/year whereas the total cost of other methods is 398 \$/year,.

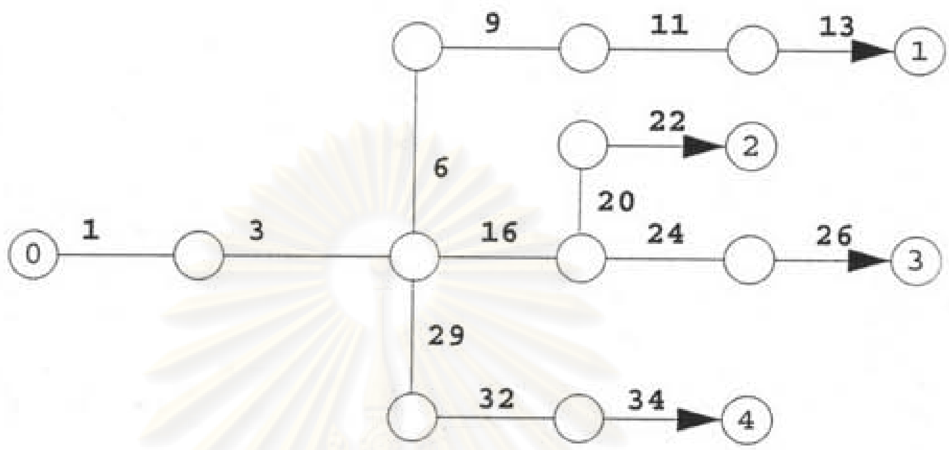

Figure 5.2: Example network with only pipes.

Table 5.6: Results of the reduced system.

number	optimum diameter, in		
	by this	by LP	by NLP
1	10	10	10
3	10	10	10
6	6	6	8
9	5	5	6
11	5	5	6
13	3	3	5
16	6	6	8
20	5	5	6
22	3	3	5
24	5	5	6
26	3	3	5
29	5	5	6
32	5	5	6
34	3	3	5