Parameter Optimization of Key Equipment in the Process of Comprehensive Utilization of Wastewater Containing Germanium

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Abstract

This paper focuses on the rotating speed parameter optimization of the tubular centrifuge, the pressure parameter optimization of the ceramic membrane filter and the parameter optimization of the high purity water equipment in the processing procedure of waste water containing germanium. The result indicates that the best rotating speed of the tubular centrifuge is 1500r/min, the best pressure of the ceramic membrane filter is 0.22Mpa, the best pressure of sand filter is 0.20Mpa and the bset pressure of active carbon filter is 0.24Mpa.

Keywords

Wastewater Containing Germanium, Parameter Optimization, Processing.

1. Introduction

In the production process of semiconductor germanium substrates, crystal rod processing, crystal rod cutting, edge grinding, thinning, polishing and other processes will generate the corresponding germanium waste and germanium waste water. Using diamond saw blade to cut head and tail of crystal rod can produce germanium waste; using the wheel to make crystal rod round can also produce germanium waste; using the line slice cutting machine to cut the crystal rod can produce the mixture of germanium powder and silicon carbide powder. Subsequent edge grinding, thinning, polishing and other processes produce mainly wastewater containing germanium. If we take germanium substrates of 10 thousand pieces as the example, wafer processing processes can produce wastewater of 10t. Germanium separation of wastewater, recycling and turning waste into treasure has important significance in terms of reducing environmental pollution and reducing production costs.

For germanium waste of crystal processing and crystal cutting process, Kun [1-3] has put forward the corresponding treatment methods of recycling metal germanium, but for the wastewater containing germanium from edge grinding, thinning and polishing process, they did not propose the corresponding processing method. The purpose of this paper is to optimize the rotational speed parameter of tubular centrifuge, the working pressure parameters of ceramic film filter and equipment parameters of high purity water preparation equipment in order to finally achieve the dual purpose of efficient metal germanium recovery and the overall cost reduction of wastewater treatment containing germanium.

2. Method Principle and Process Flow

The germanium content of waste water from edge grinding, thinning and polishing process is between 28.86mg/L and 58.16mg/L. The waste water containing germanium are pumped into the waste water tank of high level by feeding pump and then flows into the tubular centrifuge by gravity. The waste water flows into the half clear water tank after the separation of tubular centrifuge and grow into the clean water after the treatment of ceramic film filter. The clean water is pumped into the high purity water preparation system and are converted into the high purity water. The high purity water is transported to the workshop, the germanium of the whole process is recycled and reused and then the corresponding process flow chart is shown in Figure 1 and Figure 2.

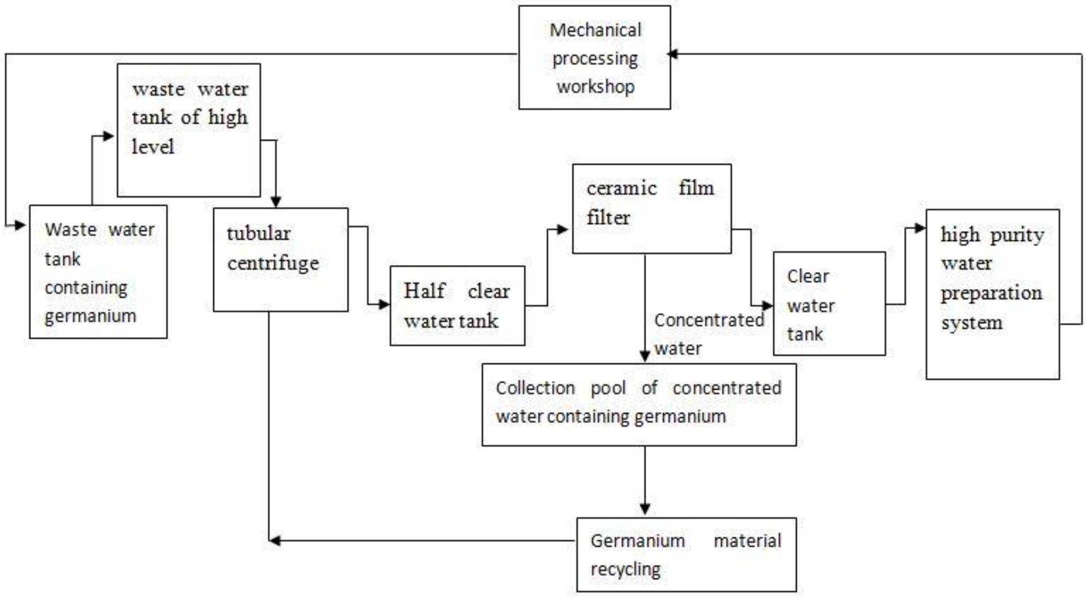

Fig.1 Process flow chart 1

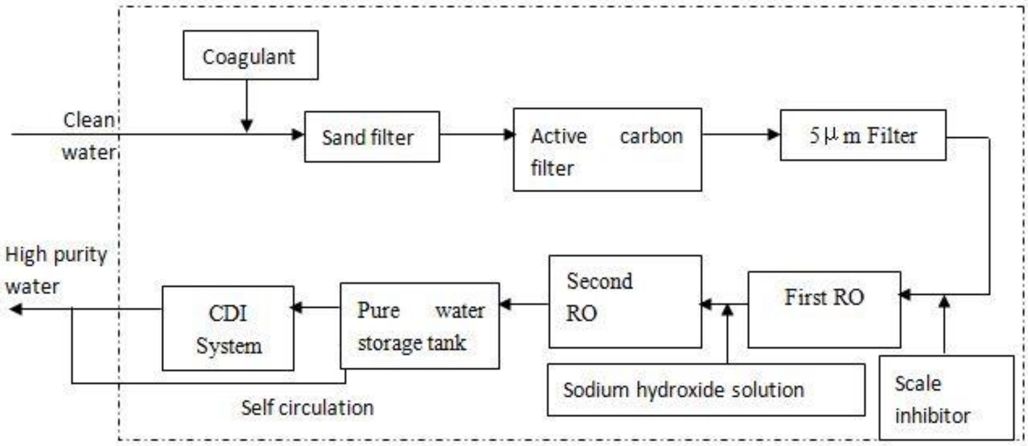

Fig.2 Process flow chart 2

3. Results and Discussion

The germanium content of intermediate water after the filtration of ceramic filter membrane has a great influence on the cost of back-section high pure water preparation. If the germanium content of intermediate water is too high, the high pure water preparation cost will remain high.

Take 5ml from the waste water containing germanium waste pool and measure the germanium content of the first waste water containing germanium for 58.16mg/L by using benzfluorenone spectrophotometric method. In order to study the influence of speed parameters of the tubular centrifuge on the germanium content of intermediate water containing germanium, keep the other key equipment parameters constant as shown in Figure 3 and choose the working pressure of ceramic membrane filter as shown in Figure 4. The measured germanium content of intermediate water containing germanium after the filtration of ceramic filter membrane by using benzfluorenone spectrophotometric method is shown in figure 4. The results showed that when the centrifuge speed range is from 400r/min to 1500r/min, the germanium content of intermediate water after ceramic filter membrane decreases with the increase of the rotation speed of tubular centrifuge. But in the speed range of 1500r/min to 1800r/min, the measured germanium content of intermediate water after the filtration of ceramic filter membrane remain unchanged.

Table 1. The parameters of relevant equipment

The parameters of relevant equipment	value	Unit
Working Pressure of Ceramic Membrane Filter	0.01	MPa
Working Pressure of Sand Filter	0.01	MPa
Working Pressure of Active Carbon Filter	0.01	MPa
Working Pressure of First RO	1.34	MPa
Working Pressure of Second RO	1.34	MPa
Working Pressure of CDI system	4.3	bar
Loading current of CDI system	3.2	A
Coagulant velocity	1.6	L/h
Scale inhibitor flow rate	1.5	L/h
Flow Rate of Sodium hydroxide solution	1.1	L/h

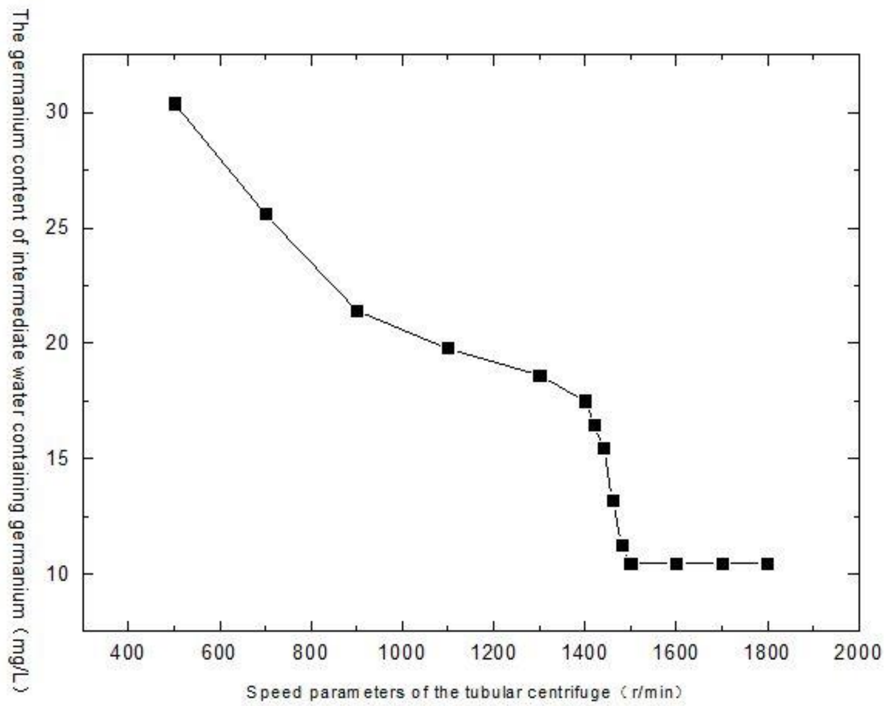

Fig.3 The effect of the rotating speed parameter of the tubular centrifuge on the germanium concentration of intermediate water containing germanium

In order to study the influence of working pressure of the ceramic film filter on the germanium content of intermediate water containing germanium, keep the other key equipment parameters constant as shown in Figure 5 and choose the speed parameter of the tubular centrifuge as shown in Figure 6. The measured germanium content of intermediate water containing germanium after the filtration of ceramic filter membrane by using benzfluorenone spectrophotometric method is shown in figure 6. The results showed that when the working pressure range of the ceramic film filter is from 0 to 0.22Mpa, the germanium content of intermediate water after ceramic filter membrane decreases with the increase of working pressure of the ceramic film filter. But in the speed range of 0.22Mpa to 0.3Mpa, the measured germanium content of intermediate water after the filtration of ceramic filter membrane remain unchanged.

Table 2. The parameters of relevant equipment

The parameters of relevant equipment	value	Unit
Speed Parameters of Tubular Centrifuge	1500	r/min
Working Pressure of Sand Filter	0.01	MPa
Working Pressure of Active Carbon Filter	0.01	MPa
Working Pressure of First RO	1.34	MPa
Working Pressure of Second RO	1.34	MPa
Working Pressure of CDI system	4.3	bar
Loading current of CDI system	3.2	A
Coagulant velocity	1.6	L/h
Scale inhibitor flow rate	1.5	L/h
Flow Rate of Sodium hydroxide solution	1.1	L/h

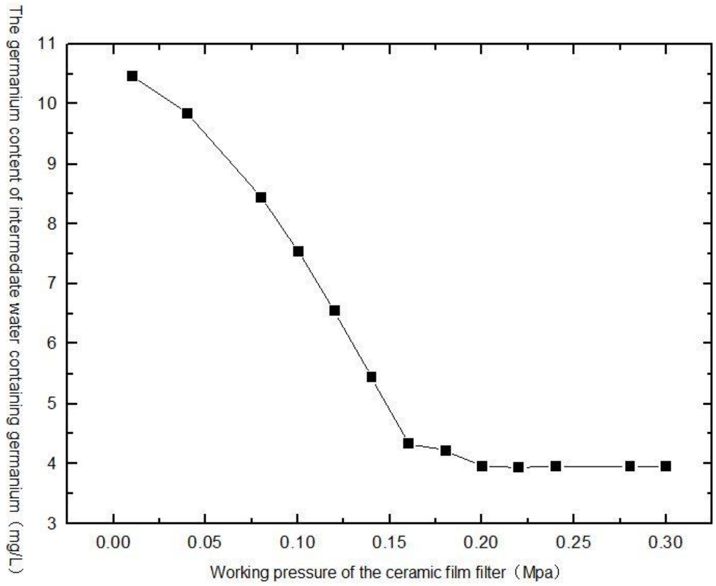

Fig.4 The effect of the ceramic membrane filter pressure on the germanium concentration of intermediate water containing germanium

Table 3. The parameters of relevant equipment

The parameters of relevant equipment	value	Unit
Speed Parameters of Tubular Centrifuge	1500	r/min
Working Pressure of Ceramic Membrane Filter	0.22	MPa
Working Pressure of Active Carbon Filter	0.01	MPa
Working Pressure of First RO	1.34	MPa
Working Pressure of Second RO	1.34	MPa
Working Pressure of CDI system	4.3	bar
Loading current of CDI system	3.2	A
Coagulant velocity	1.6	L/h
Scale inhibitor flow rate	1.5	L/h
Flow Rate of Sodium hydroxide solution	1.1	L/h

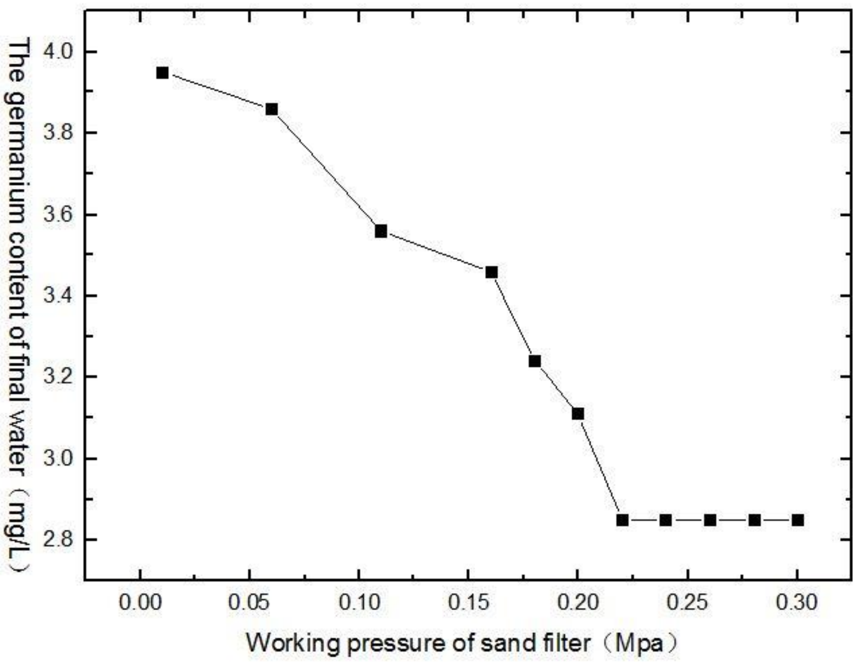

Fig.5 The effect of the sand filter pressure on the germanium concentration of final high-purity water

In order to study the influence of working pressure of sand filter on the germanium content of final water, keep the other key equipment parameters constant as shown in Figure 7 and choose the speed parameter of the tubular centrifuge and working pressure of ceramic membrane filter as shown in Figure 8. The measured germanium content of final water by using benzfluorenone spectrophotometric method is shown in figure 8. The results showed that when the working pressure range of the sand filter is from 0.01Mpa to 0.20Mpa, the germanium content of final water decreases with the increase of working pressure of the ceramic film filter. But in the speed range of 0.20Mpa to 0.3Mpa, the measured germanium content of final water remain unchanged.

Table 4. The parameters of relevant equipment

The parameters of relevant equipment	value	Unit
Speed Parameters of Tubular Centrifuge	1500	r/min
Working Pressure of Ceramic Membrane Filter	0.22	MPa
Working Pressure of Sand Filter	020	MPa
Working Pressure of First RO	1.34	MPa
Working Pressure of Second RO	1.34	MPa
Working Pressure of CDI system	4.3	bar
Loading current of CDI system	3.2	A
Coagulant velocity	1.6	L/h
Scale inhibitor flow rate	1.5	L/h
Flow Rate of Sodium hydroxide solution	1.1	L/h

In order to study the influence of working pressure of active carbon filter on the germanium content of final water, keep the other key equipment parameters constant as shown in Figure 9 and choose the speed parameter of the tubular centrifuge and working pressure of ceramic membrane filter as shown in Figure10. The measured germanium content of final water by using benzfluorenone spectro photometric method is shown in figure 10. The results showed that when the working pressure range of the active carbon filter is from 0.01Mpa to 0.24Mpa, the germanium content of final water decreases with the increase of working pressure of the active carbon filter. But in the speed range of 0.24Mpa to 0.3Mpa, the measured germanium content of final water remain unchanged.

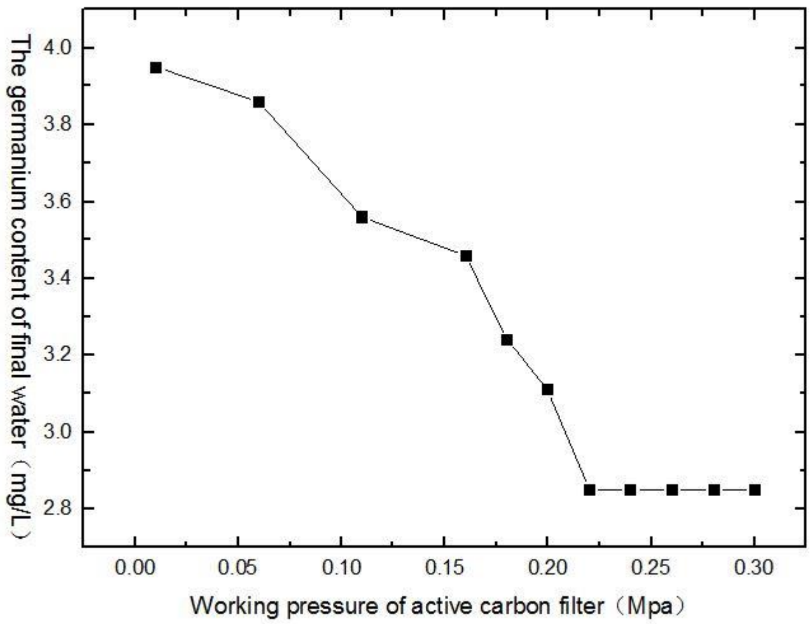

Fig.6 The effect of Active Carbon filter pressure on the germanium concentration of final high-purity water

4. Conclusion

In this paper, the influence of speed parameters of the tubular centrifuge and working pressure of the ceramic film filter on the germanium content of intermediate water containing germanium, the influence of working pressure of sand filter and active carbon filter on the germanium content of final water have been studied. Through the above analysis we get the following conclusion:

(1) The results showed that when the centrifuge speed range is from 400r/min to 1500r/min, the germanium content of intermediate water after ceramic filter membrane decreases with the increase of the rotation speed of tubular centrifuge. But in the speed range of 1500r/min to 1800r/min, the measured germanium content of intermediate water after the filtration of ceramic filter membrane remain unchanged.

(2) The results showed that when the working pressure range of the ceramic film filter is from 0 to 0.22Mpa, the germanium content of intermediate water after ceramic filter membrane decreases with the increase of working pressure of the ceramic film filter. But in the speed range of 0.22Mpa to 0.3Mpa, the measured germanium content of intermediate water after the filtration of ceramic filter membrane remain unchanged.

(3) The results showed that when the working pressure range of the sand filter is from 0.01Mpa to 0.20Mpa, the germanium content of final water decreases with the increase of working pressure of the ceramic film filter. But in the speed range of 0.20Mpa to 0.3Mpa, the measured germanium content of final water remain unchanged.

(4) The results showed that when the working pressure range of the active carbon filter is from 0.01Mpa to 0.24Mpa, the germanium content of final water decreases with the increase of working pressure of the active carbon filter. But in the speed range of 0.24Mpa to 0.3Mpa, the measured germanium content of final water remain unchanged.

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