

# EFFECT OF HYDROGEN ON THE ACTIVATION OF PITCH SPHERE CONTAINING METALS

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## Introduction

Pitch-based spherical activated carbon (PSAC) with narrow distribution of micropore is used widely for its high mechanic strength, good adsorption ability and low ash content [1]. However, PSAC with high ratio of mesopore (PSAC-M) is needed in some fields such as blood purification, catalyst carrier etc.. In this study, PSAC-M was prepared from pitch sphere impregnated with metals, and the effect of hydrogen on the activation and the formation of mesopore are mainly discussed.

## Experimental

Pitch sphere (PS) was pre-activated at 900°C in nitrogen, then was impregnated in water solution of different metallic salt ( $\text{FeCl}_2$ ,  $\text{CoCl}_2$ ,  $\text{NiCl}_2$ ), obtaining the pitch sphere containing Fe, Co or Ni (named as PS-Fe, PS-Co, PS-Ni respectively). The above pitch spheres were then secondarily activated by steam in hydrogen and nitrogen, separately. The BET surface area and pore structure of PSACs were determined by nitrogen adsorption (77K) on ASAP2000 (Micrometric Co. USA). The mesopore size distribution was calculated using Barret-Joyner-Halenda (BJH) method.

## Results and Discussion

Fig. 1 shows the relationship between activation time and burn-off of PS-Fe, PS-Co and PS-Ni during activation by steam in hydrogen and nitrogen. It is indicated that the activation rate in hydrogen is higher than that in nitrogen, especially for the PS-Fe. Therefore, hydrogen promoted the Fe, Co or Ni-catalyzing activation reaction between carbon and steam.

The mesopore size distribution of PSACs obtained from PS-Fe, PS-Co and PS-Ni, which are respectively named as PSAC-Fe, PSAC-Co and PSAC-Ni, in nitrogen and hydrogen were illustrated in Fig.2 and Fig. 3. Comparing the two figures, it can be seen that the

mesopore in PSACs activated in nitrogen were mainly distributed at 2nm, while that of PSACs activated in hydrogen were mainly distributed at the region of 10-50nm. Some macropore (pore size > 50nm) occurred in these PSACs obtained in hydrogen. It can be explained as follows.

Metal particles catalyzed the activation reaction between carbon and steam, pitting holes into carbon matrix, forming mesopore [2]. Hydrogen can increase the metal-catalyzing activation rate (Fig.1) and heightening the catalytic activity of metals, creating larger mesopore (Fig.3).

BET surface area, mesopore volume and ratio of mesopore of pre-activated pitch sphere, PSAC-Fe, PSAC-Co and PSAC-Ni are listed in Table 1. The burn-off or these PSACs in Table 1 are similar (about 46%). The results show that PSACs activated in nitrogen have higher BET surface area, while those activated in hydrogen have higher mesopore volume and mesopore ratio. It is because that PSACs activated in hydrogen have large mesopores (10-50nm) and some macropores (>50nm) which are main contributor to the pore volume, while PSACs activated in nitrogen only have little mesopores (2nm) which contributed to BET surface area much more than to pore volume.

## Conclusion

Hydrogen can promote the Fe, Co or Ni-catalyzed activation rate between carbon and steam, and has advantage to increase mesopore size and mesopore ratio in resultant PSACs than nitrogen.

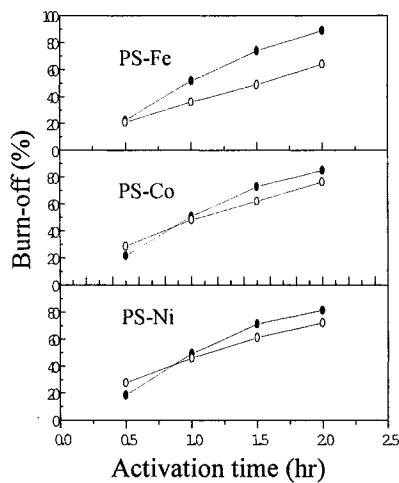
## References

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2. Mims CA. Catalytic gasification of carbon:

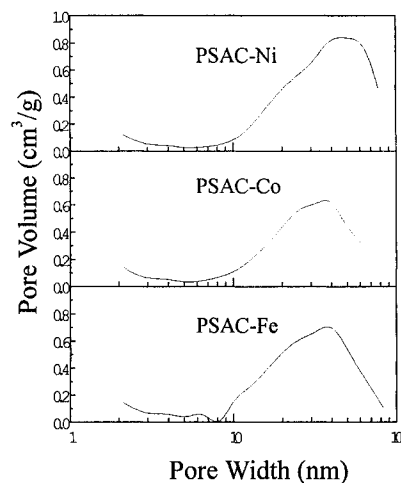
**Table 1.** BET surface area, mesopore volume and mesopore ratio of pre-activated carbon and PSACs obtained from PS-Fe, PS-Co and PS-Ni.

Samples	Activation atmosphere	BET surface area (m <sup>2</sup> /g)	Mesopore volume (cm <sup>3</sup> /g)	Mesopore ratio* (%)
Pre-activated PS	-----	683	0.037	12
PSAC-Fe	nitrogen	1100	0.23	58
PSAC-Co	nitrogen	1112	0.26	67
PSAC-Ni	nitrogen	1010	0.24	52
PSAC-Fe	hydrogen	558	0.48	76
PSAC-Co	hydrogen	586	0.41	71
PSAC-Ni	hydrogen	574	0.56	77

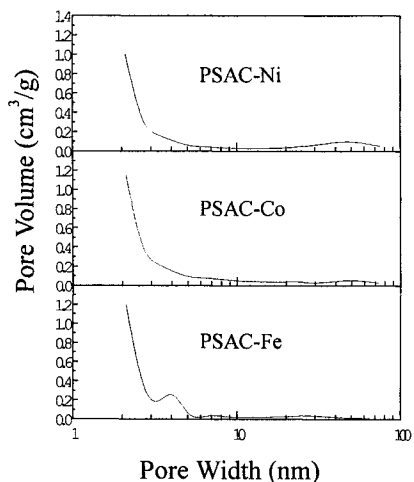
\*obtained from the ratio of mesopore volume to total pore volume.



**Figure 1.** Relationship between activation time and burn-off of PS-Fe, PS-Co and PS-Ni activated by steam in nitrogen (o) and hydrogen (●).



**Figure 3.** Pore size distribution of PSAC-Fe, PSAC-Co and PSAC-Ni obtained in hydrogen.



**Figure 2.** Pore size distribution of PSAC-Fe, PSAC-Co and PSAC-Ni obtained in nitrogen.