

FINAL REPORT

**Outbursting
Scoping Study**

**C4034
March 1996**

9.2 OUTBURST PREDICTION INDICES

A number of outburst prediction indices have been used in different countries. The methods used to determine these indices are given below.

9.2.1 Ettinger's Sorption/Desorption Index

Ettinger (1952) was the first to point out the role of high rates of emission (desorption) of gas in outbursts based upon laboratory experiments, though view on this subject were aired much earlier by Bykov (1936), Krichevski (1948), Vladimirovski (1948) and Ettinger (1952). The method is based upon crushing a sample, drying it to 60° and evacuating it to remove any residual gas. The sample is sorbed with gas to equilibrium at 1 atm. pressure (absolute) at 30°C.

Low pressure studies were conducted to ensure that changes in temperature due to sorption and desorption are minimised. The particle size chosen was 0.25 - 0.5 mm. This size was chosen as this best differentiated the outbursting from non-outbursting coals. He compared the sorption rates of 5 different anthracites with volatile matter rate of 3.56% to 6.27% (Fig. 9.2) and showed that in spite of the fact that their sorption capacity at 1 atm. pressure is the same, the sorption rate (and so also the desorption rate) is quite different. Coals with high sorption/desorption rates are liable to outbursts (samples 1, 2 and 3). Sample 4 comes from a seam where outbursts occurred very rarely and in-seam (sample 5) outbursts never occurred. Similar results were found for samples with low-medium and medium volatile coals (Figs. 9.3 and 9.4). In Fig. 9.3, seam 1 is highly liable to outbursts and seam 3 is not liable to outbursts. In Fig. 9.4, seam 1 is very highly liable to outbursts and seam 2 is the destressing seam which has very low liability to outbursts. Ettinger suggested that the sorption/desorption rate in the first 30 seconds should be taken as the reference value.

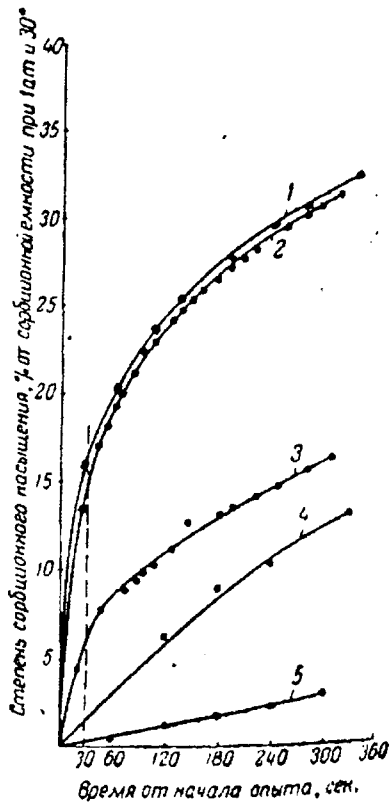


Fig. 9.2. Sorption rates of 5 anthracite coal seams (Ettinger, 1952).

y-axis = percentage of sorption capacity at 1 atm pressure and 30°C

x-axis = sorption time

1. Sorption capacity = 6 cc/g, Vol = 4.82%,
2. Sorption capacity = 5.67 cc/g, Vol = 6.27%,
3. Sorption capacity = 7.0 cc/g, Vol = 4.72%
4. Sorption capacity = 7.52 cc/g, Vol = 3.5%,
5. Sorption capacity = 6.4 cc/g, Vol = 6.12,

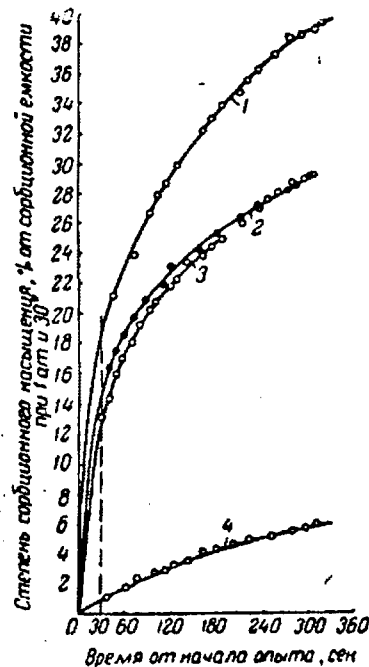


Fig. 9.3. Sorption rates of 5 anthracite coal seams (Ettinger, 1952).

y-axis = percentage of sorption capacity at 1 atm pressure and 30°C

x-axis = sorption time

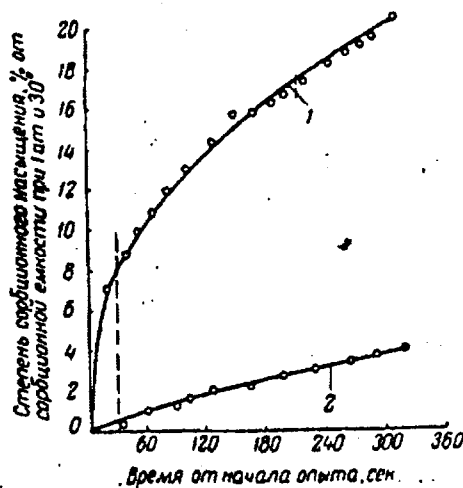
1. Sorption capacity = 3 cc/g
Vol = 12.2%, highly liable to outbursts
2. and 3. Sorption capacity = 3.15 cc/g,
Vol = 16.5%,
4. Sorption capacity = 2.3 cc/g,
Vol = 22.8%,

(Sample 2 taken from the outburst cavern, and sample 3 from the same seam but not from the outburst site.)

Fig. 9.4. Sorption rates of 2 anthracite coal seams (Ettinger, 1952).

y-axis = percentage of sorption capacity at 1 atm pressure and 30°C
x-axis = sorption time

- Seam 1 = highly liable to outbursts,
sorption capacity = 3.58 cc/g,
Vol = 21.6%
- Seam 2 = destressing seam,
sorption capacity = 2.45 cc/g,
Vol = 24.1%



In 1953, Ettinger et al, (1953) present further data, where instead of measuring the rate of sorption/desorption as a percentage of the gas sorbed at 1 atm pressure, they suggested gas pressure build up in an enclosed chamber of definite dimensions. The rate of gas emission expressed as "gas emission index" in terms of rise in pressure in mm of Hg and the liability of a coal seam to outburst is expressed as follows:

- $\Delta P \leq 5$, coal not liable to outbursts
- $\Delta P = 5 - 15$, coal liable to outbursts
- $\Delta P = 15 - 20$, coal highly liable to outbursts.

In their studies, they found that even carbonaceous shales containing up to 50% ash may have high sorption rate and outbursts can occur in these beds.

Seams contain bands with high sorption/desorption rate, but the width of these bands is much higher in seams liable to outbursts compared with seams not liable to outbursts. Lidin et al (1954) present data in categorising sections of seams and zones of a coal seam.

These basic research publications of Ettinger and his colleagues have formed the basis of virtually all sorption desorption indices.