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TRANSPORT OF GASES IN A DRY WHEAT GRAIN

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The examinations of gas transport in grain are difficult because of experimentation and complexity due to a variety of processes involved.

The following experiment was carried out to estimate gas diffusion velocity in a single wheat grain: A tube of the interferometer was filled up with gas and next closed up with metal rings, with single wheat grains closely put inside (Fig. 1). Figure 2 presents a decrease in the concentration of the gases examined He and Ne in the tube of the interferometer. The above decrease indicates a slow rate of the diffusion of the gases through single grains.

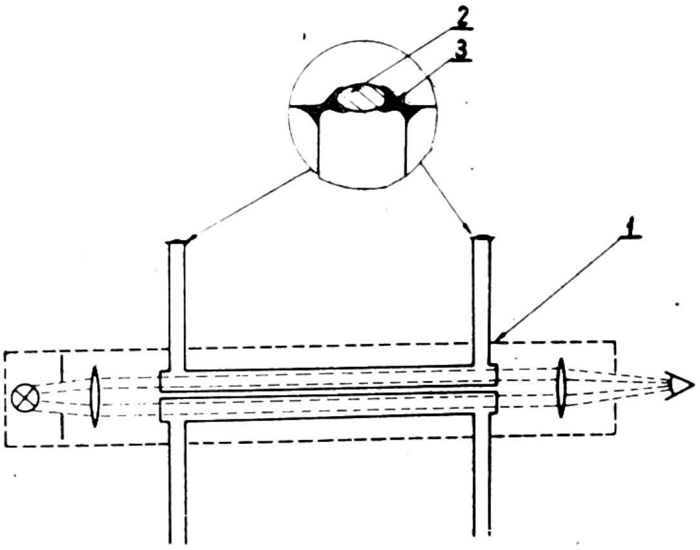

Fig. 1. The apparatus for measurement of gaseous diffusion through a single grain: *1* — tube of the interferometer with the gas examined, *2* — grain, 3 — sealing material

Next, measurements were made of the effective parameters of the gas exchange in the grains under the conditions similar to those of storing, i.e. in a self-made layer. The saturation and desaturation pro-

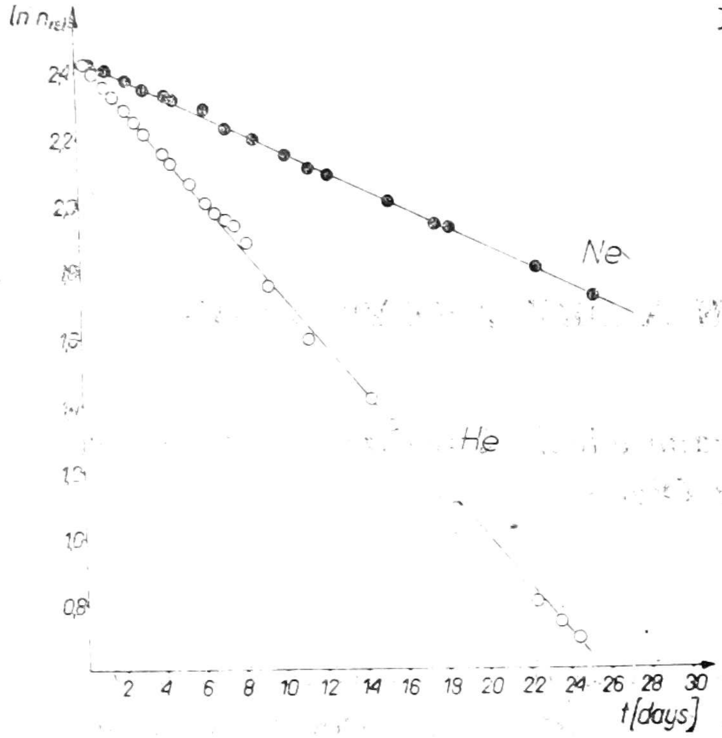

Fig. 2. Concentration decrease of He and Ne in the measurement apparatus

cesses of grain were called the cycle of gaseous exchange, effected by the apparatus, as shown in Fig. 3.

The examined gas was introduced by a pump *4* from the container *8* into the cylinder *1* filled with dry wheat grains *2* of the Grana variety. The saturation process took place at a time closely defined i.e. saturation time. Next a current of thermostatic and dry air was introduced into the apparatus. By flowing through the cylinder, filled with saturated grain, the air absorbed the gas relased from the grain. Gas concentration variations in the air current were recorded by the interferometer *3*.

Figure 4 presents a resistance-capacity model for gas exchange in grains. Capacities C_i' $(i = 1, ..., m)$ show gaseous capacities of the basic cells among the grains. Resistances R_i' give gaseous resistance between

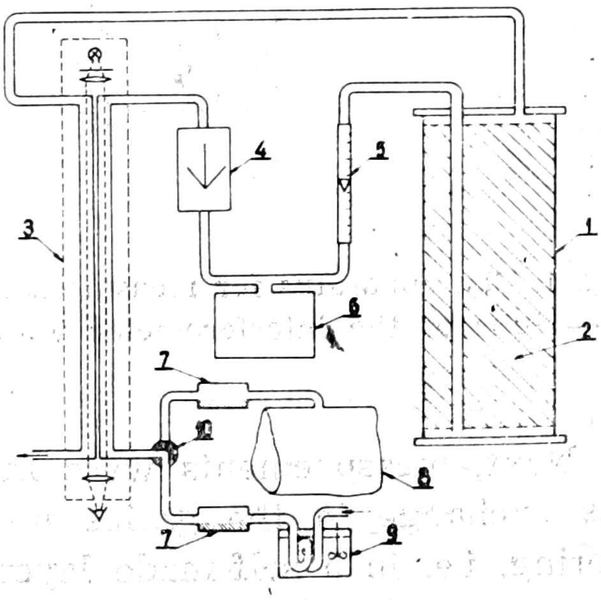

Fig. 3. The apparatus for measurement of the gas exchange parameters in grain: *1* — cylinder with grain, *2* — wheat grain, *3* — interferometer, *4* — a pump for constant flow of the studied gas (or air) through the apparatus, *5* — rotameter, *6* — container stabilizing gas flow, *7* — gas blotters, *8* — container with the examined gas, *9* — thermostat, *10* — inlet valve

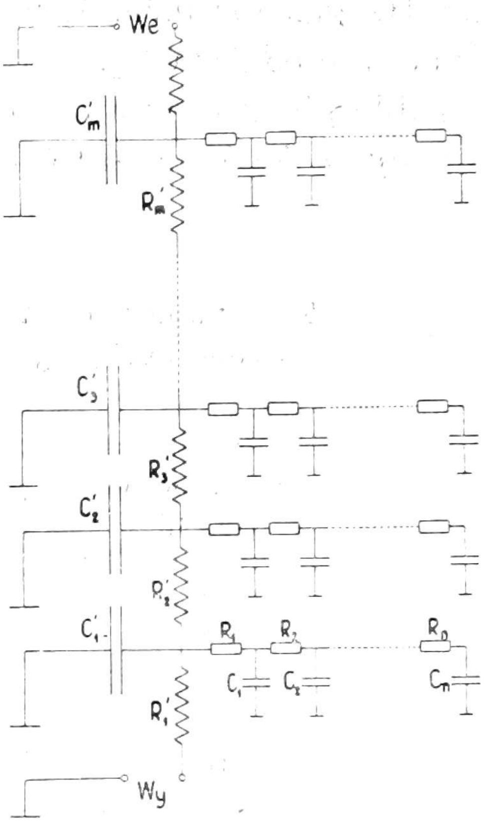

Fig. 4. Resistance-capacity model for measurement of gaseous exchange in grains put in a layer

the cells. Capacities C_j ($j = 1, ..., n$) indicate gaseous capacities of the basic cells of a single grain and resistances R_j — gaseous resistances between the cells ($R_j' \ll R_j$). Resistances R_j and capacities C_j put in line RC are the model of a single grain.

Figure 5 shows a decrease in He concentration in a current of air flowing with velocity $v = 0.5$ l/min through a wheat layer saturated

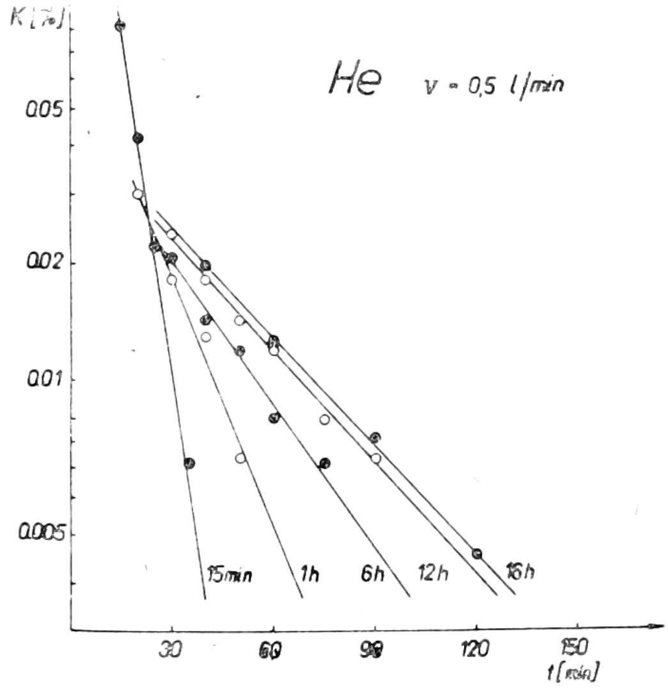

Fig. 5. Concentration decrease of He in a current of air through a grain layer, after different saturation time

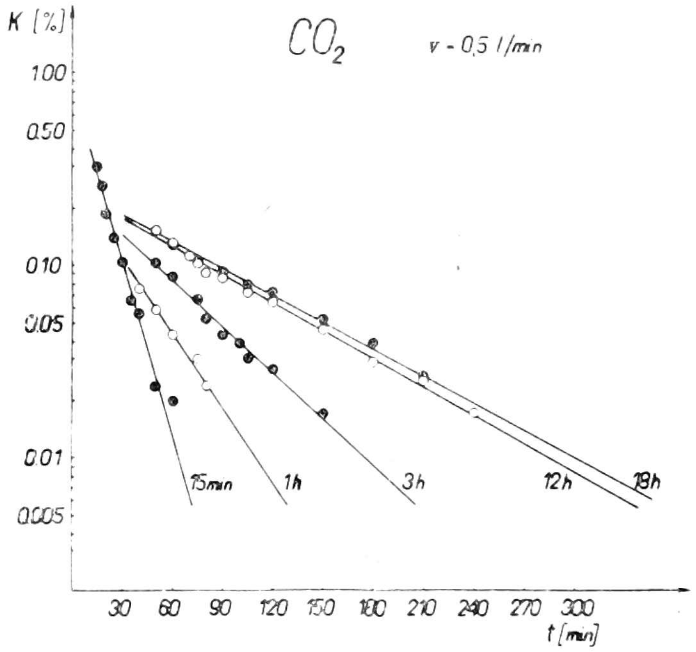

Fig. 6. Concentration decrease of CO_2 in a current of air through a grain layer, after different saturation time

with He gas for 0.25, 1, 6, 12, 18 hrs. Figure 6 shows the respective results obtained for CO_2.

Table gives the values of the effective coefficients velocity of gaseous exchange α for He and CO_2 at different saturation times.

Table 1

The values of the effective coefficients of velocity of gaseous exchange α for He and CO_2 at different saturation time

Saturation time t_n [h]	He $\alpha \cdot 10^4 [s^{-1}]$	Saturation time t_n [h]	CO_2 $\alpha \cdot 10^4 [s^{-1}]$
0.25	45.0	0.25	8.1
1	7.5	1	4.0
6	4.9	3	2.9
12	3.3	12	1.9
16	3.3	18	1.9

Figure 7 shows the volumes of He and CO_2 relased by 1 kg of Grana grains depending on saturation time.

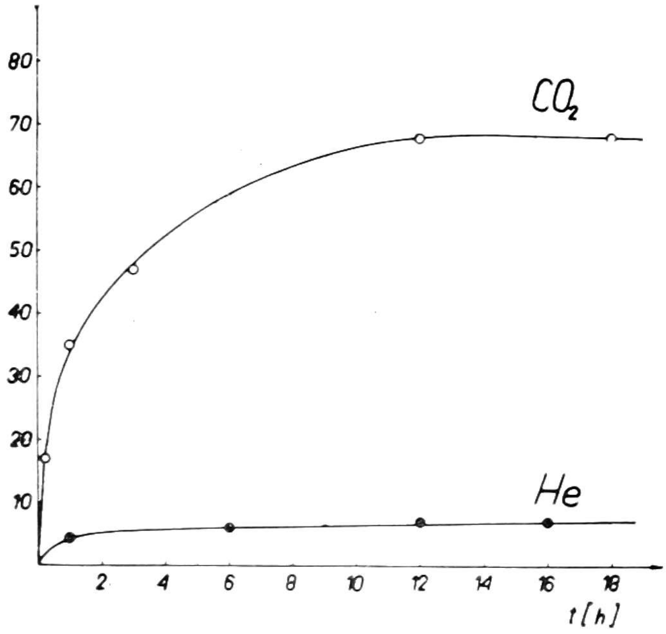

Fig. 7. A relationship of the gas volume to saturation time (by gas volume is meant that which the grain can release in a single cycle of the gaseous exchange)

A comparison of the velocity coefficient values of the gaseous exchange for He and CO_2 and that of the volume values for He and CO_2, received and released in an exchange cycle, permit a conclusion that the sorption process prevails over diffusion process.

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DYFUZJA GAZÓW DO WNĘTRZA ZIARNA PSZENICY

Streszczenie

W pracy autorzy starali się określić dwa podstawowe parametry dyfuzji gazów do wnętrza ziarna: pojemność gazową ziarna i jego opór gazowy. W wymianie gazowej w takim ośrodku porowatym, jak ziarno uczestniczyć mogą procesy dyfuzji, adsorpcji, rozpuszczania i inne. Ze względów utylitarnych i metodycznych autorzy traktują wymianę gazową jako proces dyfuzji efektywnej. W związku z tym opracowany został prosty model elektryczny (pojemnościowo-oporowy) transportu gazu do wnętrza i z wnętrzna ziarna. Następnie opracowana i wykonana została aparatura, przy użyciu której badano te procesy. Jako detektora określającego zmiany koncentracji gazu w komorze zawierającej ziarno użyto interferometru. Pierwsze pomiary wykonano dla suchych ziarn pszenicy Grana. Do pomiarów używano około 2 kg ziarna, badano transport helu i dwutlenku węgla. Niezależnie od tego wykonany został eksperyment określający prędkość dyfuzji helu i neonu przez pojedyncze ziarno.

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ДИФФУЗИЯ ГАЗОВ ВНУТРЬ ЗЕРНА ПШЕНИЦЫ

Резюме

В настоящей работе авторы старались определить два основных параметра диффузии газов внутрь зерна: газовую емкость зерна и его газовое сопротивление. В такой пористой среде, как зерно, в газообмене могут участвовать процессы диффузии, адсорбции, растворения и др. По практическим и методическим соображениям авторы рассматривают газообмен как процесс эффективной дифузии. В связи х этим была разработана простая электрическая (емкостно-резистивная) модель транспорта газа внутрь и изнутри зерна. Затем была сконструирована аппаратура, при помощи которой исследовались эти процессы. Детектором для определения изменения концентрации газов в камере с зерном являлся интерферометр. Первые измерения были проведены для сухих зерен пшеницы Грана (2 кг). Исследовали транспорт гелия и углекислого газа. Кроме того был проведен эксперимент, определяющий скорость диффузии гелия и неона сквозь единичное зерно.

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