MICRORADAR
Laboratory and on-line microwave moisture meters

MICRORADAR-SERVICE LTD
https://www.mining-microwave-moisture-analyzer.microradar.com

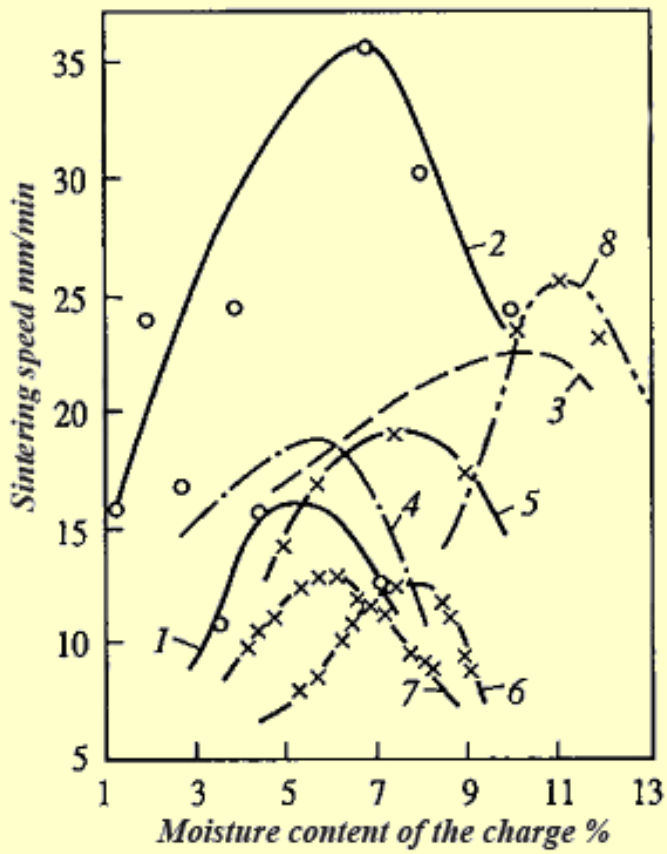
MICRORADAR115V13K is a means of optimizing the moisture content of raw materials during agglomeration and production of pellets of metal ore concentrates.

According to the materials of the ESTAD (European Steel Technology and Applications Days) 2015, the installation of a moisture meter and automation of the agglomerate humidification system at SAIL helped increase productivity by 12%, strength from 68 to 71, and reduce the fine fraction from 12% to 8%.

Agglomeration of iron ore and fine concentrates prior to blast furnace smelting significantly improves the technical and economic performance of blast furnaces and increases their productivity. The significant capital expenditures on the construction and operating costs of ore agglomeration plants are relatively quickly offset by coke savings and increased iron production from pre-agglomerated raw materials. Currently, the industry uses two agglomeration methods: agglomeration of ores and concentrates and pelletization of concentrates.

Agglomeration

The first belt sintering machine, the design of which was proposed in 1906 r. by the Americans A. Dwight and R. Lloyd, was put into operation in 1911 r. Sintering machines of this type have become widespread in many countries. Currently, more than 1,000 sintering machines are in operation worldwide, with a total capacity of up to 500 million tons of sinter per year.



The agglomeration process involves the suction or blowing of gases through the sintered bed. The amount of air supplied to the solid fuel combustion zone determines the combustion rate of the coke breeze particles, while the amount and temperature of the gases leaving the combustion zone gaseous reaction products—the intensity of heat transfer beneath this zone. In this regard, the vertical sintering rate during vacuum agglomeration in the overwhelming majority In many cases is directly proportional to its gas permeability. Therefore, when preparing the batch for sintering, engineering staff at sintering plants should pay more attention to increasing its gas permeability.

Figure 1. Relationship between charge moisture content and vertical sintering velocity 1 — charge of Magnitogorsk deposit, Urals; 2 — manganese ore; 3 — concentrate of Kerch ore enrichment; 4 — Olenegorsk concentrate, Kola Peninsula; 5 — charge of Vysokogorsk agglomeration plant, Siberia; 6 — concentrate of Kursk magnetic anomaly; 7 — magnetite concentrate of Nizhny Tagil, Siberia; 8 — English brown iron ores.

As Fig. 1 shows, the sintering rate has a clearly defined maximum at a certain humidity for concentrates from different deposits.

Pelletizing

Before sintering, the moistened charge is pelletized in rotating drums, where the concentrate rolls onto the surface of larger ore particles and return material. These same drums also moisten the charge to an optimal level, ensuring optimal agglomeration, gas permeability, and, consequently, maximum vertical sintering speed. The moisture content of the charge entering the pelletizing process typically ranges from 2% to 5%. Continuous monitoring of the actual charge moisture content is performed using moisture meters, whose readings are used to maintain the optimal moisture content.

For most **pelletizing processes (disc and drum pelletizers),** the optimum output moisture is typically in the range of **6–12%,** often around **~8–10%** for concentrates of typical mill size.

Wetter concentrate cakes require preliminary adjustment/drying and/or adjustment of the binder dosage – plants set strict limits on cake moisture before feeding.

The effect of moisture on pellet properties: too little water → poor aggregation, many "dusty" pellets; too much → increased porosity, reduced strength after drying, and reduced induration (firing). A balance is often achieved through the selection and dosage of binder (bentonite/organic).

At optimal humidity, an acceptable compromise is achieved between:

Satisfactory granulation/pelletization rate (productivity).

High mechanical strength of pellets .

Minimum consumption of binder and acceptable porosity/permeability after firing.

Low energy consumption for drying/firing and process stability.

In the commodity structure of the world trade in iron ore raw materials, the largest share is occupied by fine magnetite ore (concentrate), which accounts for more than 80% of the total production of iron ore concentrates.
Magnetite, a ferromagnetic material, has significantly different electrical properties from other iron ores. The conductivity of magnetite ores at a frequency of 50-100 MHz is 10-100 times higher than that of hematite and siderite ores. The microwave absorption coefficient in magnetite ores is tens to hundreds of times higher than that of other ores, making it impossible to measure the moisture content of magnetite concentrates using conventional microwave amplitude-phase analyzers, which have proven effective in measuring other materials. Our research shows that 1 смiron ore magnetite concentrate attenuates the microwave signal by 30 to 50 dB at a frequency of 2 GHz, while conventional dielectrics attenuate by 3-5 dB. The typical thickness of a concentrate layer on a conveyor belt is 150- 250 мм. Since 75-80 dB is the sensitivity limit of all modern microwave moisture meters operating on the transmission of material, the use of such moisture meters to measure the moisture content of iron ore magnetite concentrate seems impossible.

Proposed solution

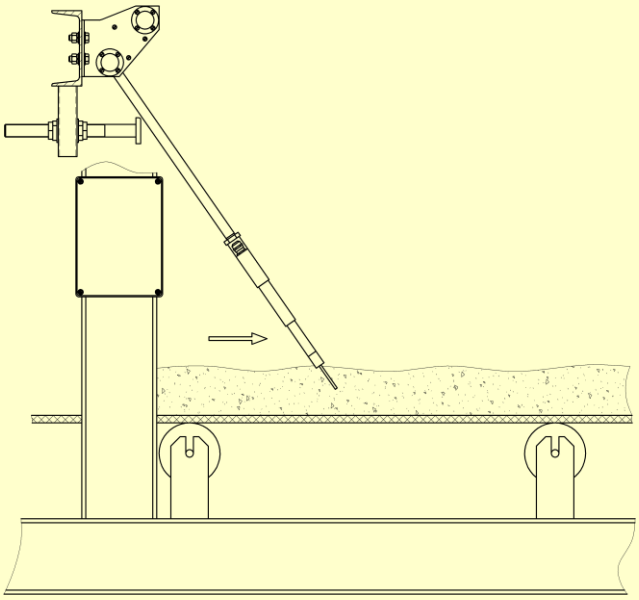
MICRORADAR LTD offers a new solution – **the MICRORADAR115V13K** , a contact moisture meter with two exposed antenna sensors immersed in the material. This solution maintains the working base 50 мм, which is sufficient for stable system operation. Made of carbide materials and wear-resistant high-hardness polyurethane. (After six months of use, wear is not noticeable.) **Link 1**
The moisture meter provides automatic correction of measurement results when the material temperature changes, has a current output and a serial RS -485 communication channel with the computer. The sensor signal is sent to the microprocessor processing unit, in which humidity calculations occur. The humidity value is displayed on the microprocessor unit's indicator panel and converted into a 4-20 mA analog output.

The device comes with a program for storing and displaying humidity in real time, which allows you to record, monitor, store, and print humidity information for any period of time on your computer.

Main technical parameters of the MICRORADAR115V13K moisture meter for sinter mixture and iron ore concentrate

Parameter	Parameter characteristic
Range of measured moisture content for sinter charge and iron ore concentrate, %	from 2 to 11
Temperature of controlled material, °C	from +5 to +95
Thickness of material layer on tape, mm.	from 70 to 400
Current output standard (selectable), mA	0…5; 0…20; 4…20
Supply voltage, V	~ 90-260 or constant =24 ±3
Power consumption, V •A	no more than 50
Overall dimensions of sensors, mm	430x180x45

The accuracy of moisture measurement for sinter charge and iron ore concentrate ranges from 0.15% to 0.5% abs. depending on the moisture range, taking into account sampling error and the error in moisture measurement by a standard method, such as drying in a drying oven.

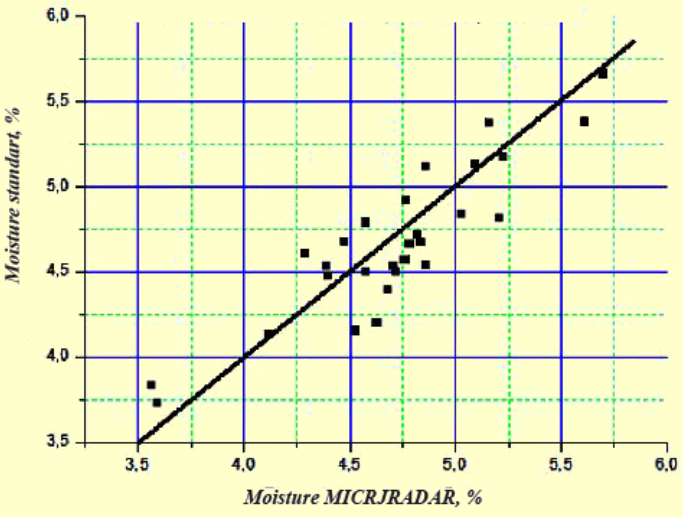


The sensor installation diagram is shown in the figure. The design allows the sensor to be taken out of service for inspection and maintenance without stopping the conveyor.

Tests and experience

Results of industrial tests at JSC EVRAZ KGOK, Kachkanar. Agglomerate mixture and screenings.

More than 10 devices have been installed at EVRAZ KGOK JSC in Kachkanar. Pictured is one of the devices installed at the sintering batch plant. During the tests, more than a hundred samples of wet material were taken and a comparison of the moisture content of the samples obtained by the laboratory was made with the moisture content of the sinter mixture as measured by a moisture meter. The moisture meter error, calculated without taking into account the laboratory error, was 0.34%; taking into account the laboratory error will give an error of 0.18%, which is significantly better than the stated error of 0.5%.



You can see the device in operation under production conditions by **link 2**

Several moisture meters have been installed on the screenings at the Kachkanar Mining and Processing Plant.

You can see the device in operation under production conditions using screening at **link 3**

Results of industrial tests at JSC Karelsky Okatysh, Kostomuksha. Iron ore concentrate.

During the tests, 40 samples of wet concentrate were taken and a comparison was made between the moisture content of the samples obtained by the laboratory and the moisture content of the sinter batch according to the moisture meter.
The moisture meter error, calculated without taking into account the laboratory error, was 0.24%.

For working with iron ore concentrate, additional sensor weights were used, as shown in the photograph.
You can see the device in operation under production conditions by **link 4**

Compliance with the standards of the Technical Regulations of the Customs Union:

004/2011 "On the safety of low-voltage equipment",
020/2011 "Electromagnetic compatibility of technical equipment"

Compliance with EU directives:

•Electromagnetic Compatibility Directive (EMC) Directive 89/336/ EEC)
•Low Voltage Directive (The low voltage 93/68/ EEC)

The radiation density level of the microwave generator is no more than 0.5 mW/cm2 , which does not exceed the limit established for non-ionizing radiation by the international standard OSHA 1910.97 (10 mW/cm2) , due to which no special safety measures are required

Registered in the register of documents No. P031560