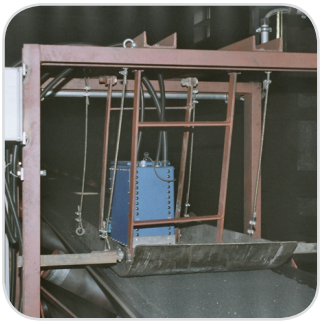
INDU TECH
process controls



Coal Ash Analyzers

Applications
- Ash content
- Moisture content
- Calorific Value
- Ash fusion
- Volatiles
- Type recognition
- Distinction between Coal, Coke, Petrolcoke and Slag

Features
- Fast quality control
- Reliable and safe
- Low operating costs
- Fast amortization

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Indutech´s Online Ash Analyzers

Indutech offers a wide range of ash analyzers to solve different applications in an optimal manner.

Gamma Transmission Ash Analyzers (GTA)

The models of the GTA thousand series are standard Dual- and Triple Energy instruments.

GTA 1000-Series

The GTA 1000 models are based on the Dual Energy technique. Fig. 1 shows the scheme of this method. Hereby the average atomic number of the material is determined by transmitting the material with two gamma beams of different energies. The average atomic number is a measure for the ash content, because the atomic number of the elements of coal (H, C, O) is lower compared to the elements of ash (Al, Si, Ca, Fe).

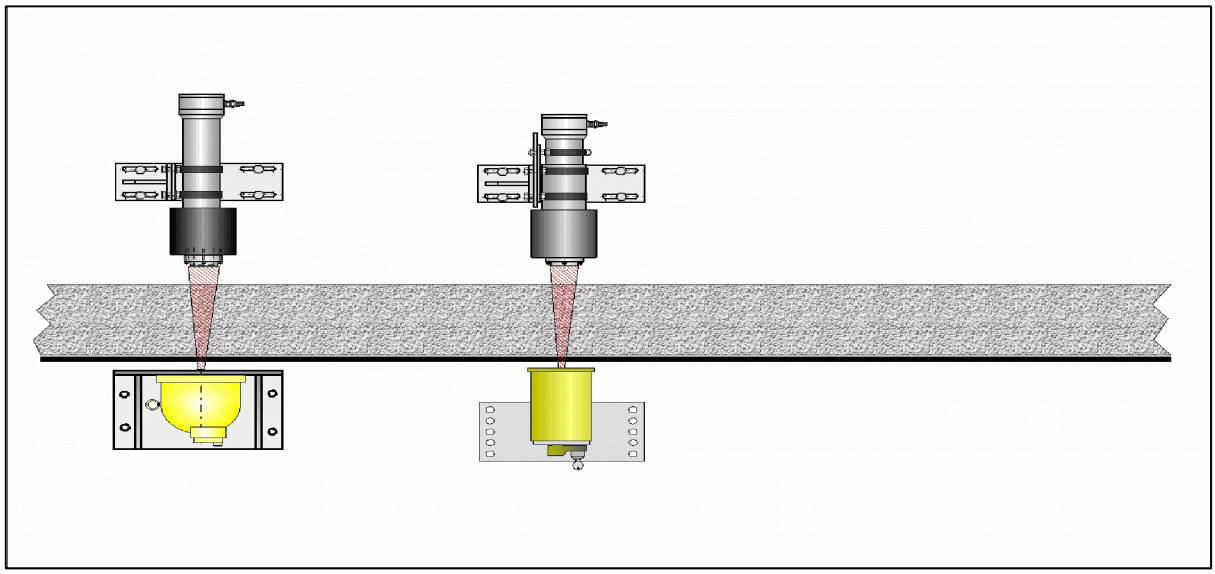

Fig. 1: Scheme of the dual energy method

However, this method is influenced by changes of the elemental composition of the ash, because hereby the average atomic number varies in spite of a constant ash content. Especially a variation of both, Iron and Calcium content, is disturbing. e.g. a 1% change of the Iron content in the product disturbs the reading of the ash meter by about 8%.

The GTA analyzers work contactless. The minimal layer thickness is approx. 5 cm. The maximum layer thickness depends on the ash content and on the energy of the low-energy radiation and is typically between 15 and 25 cm.
The method is inexpensive and therefore very popular, but the applications are limited because of the iron and Calcium influence.

The instruments of the GTA line are installed mainly in Coal Mines/Coal Washeries, because here short term changes of the elemental composition of the ash are

comparable low, and only seldom in power station, where the elemental composition of the ash is strongly varying, because coal of different origin is used.

GTA 1000-1 Dual Energy Ash Analyzer with Am and Cs
GTA 1000-1 works with Americium (Am) and Cesium (Cs) as low and high energy gamma source, respectively. The energy of the Am-241 source is 60 keV and hereby the maximal layer thickness is limited to about 25 cm.

GTA 1000-2 Dual Energy Ash analyzer with X-ray tube and Cs
At the GTA 1000-2 the toxic Americium-source is replaced by an X-ray tube. In addition to the environmental aspect this set up gives a better accuracy, because the energy of the X-ray tube is adaptable to the measuring conditions. To maximize the measuring effect an energy is selected, which is as low as possible, but, of course, large enough to penetrate through the given layer. The maximal layer thickness is limited to about 15 to 20 cm.

GTA 2000 Triple Energy Ash Analyzer with Cs, Am and X-rays
GTA 2000 is the combination of GTA 1000-1 and GTA 1000-2. Fig. 2 shows the

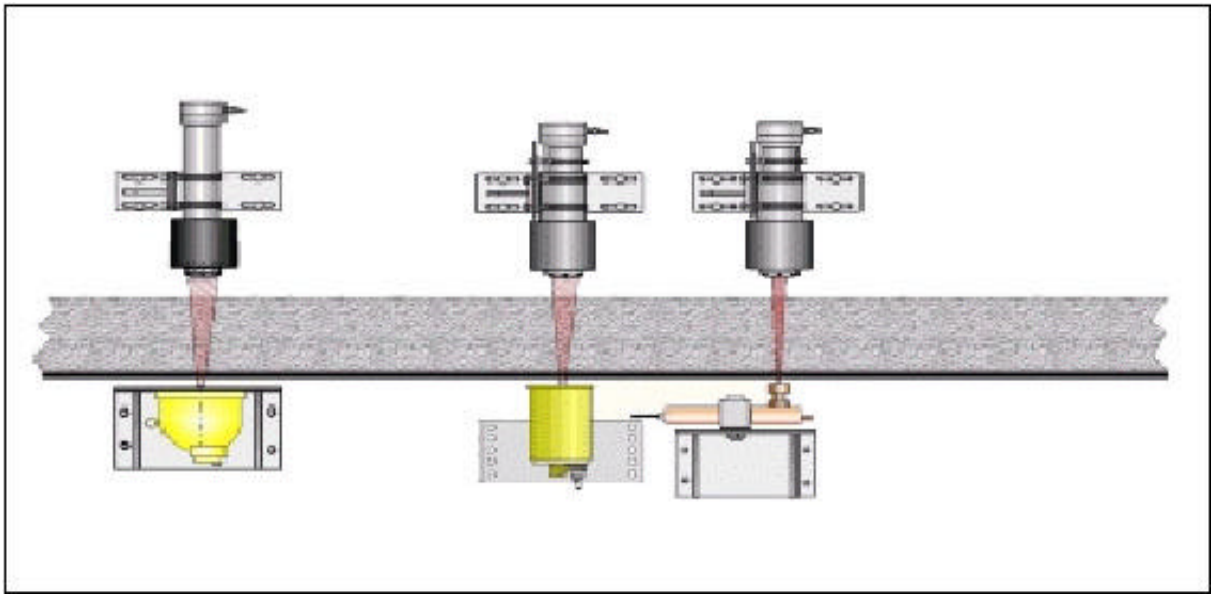

Fig. 2: Scheme of the Triple Energy Method

scheme. Because of the different energies of the Am and the X-ray radiation two different signals for the average atomic numbers are obtained which allow an iron compensation to some extent. Fig. 3 shows an GTA 2000 installation. If the concentration of more than one element is varying, e.g. Iron and Calcium, the efficiency of the compensation is reduced. This method is the most inexpensive possibility of an iron compensation, but the applicability is limited.

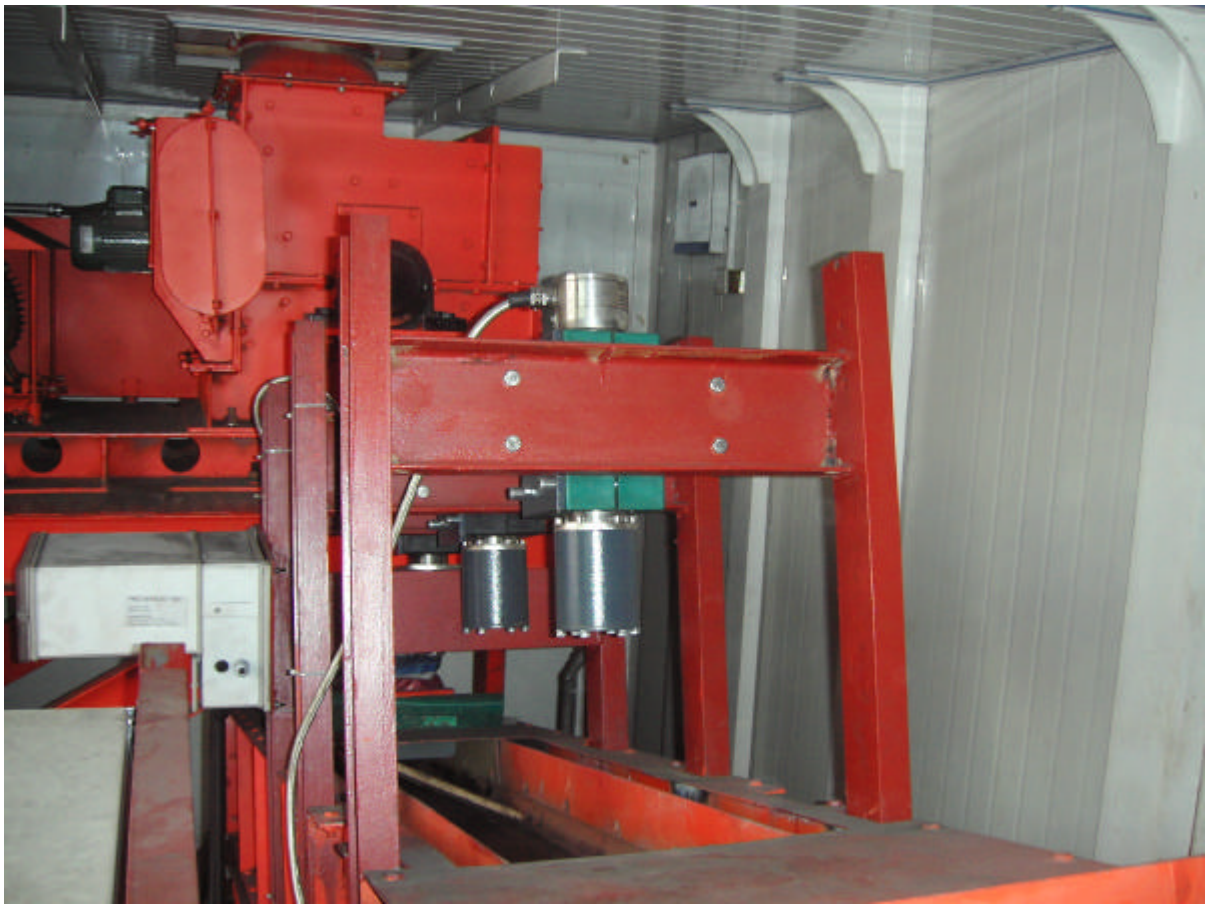

Fig. 3: GTA 2000 at a bypass belt

OXEA® Online X-ray Elemental Analyzer

The OXEA® product line is based on the principle of X-Ray fluorescence (XRF). This method gives noticeably more information than the dual energy method, because the concentration of all constituents of the ash are determined. This technique allows also to determine the ash content with a fully compensation of the elemental composition of the ash, especially iron and calcium.

PGNAA	**XRF**
▪ Californium source or neutron tube - lifetime approx. **2** years - **disposal costs** - **high maintenance costs**	▪ X-ray tube - lifetime approx. **6** years - **no** disposal costs - **low maintenance cost**
▪ **High** energy neutron and gamma radiation - **complex** shielding - **difficult** licensing because high radiation problems	▪ **Low** energy X-rays - **simple** shielding - **easy** licensing because low radiation
▪ Measures all elements. **Restrictions**: - **no detection** for some elements, e.g. **oxygen** - oversensitive detection of some elements, eg. 1% of **chlorine** saturates the detector	▪ Measures all elements with **Z > 10**
▪ **Non-integral** volume measurement - material layers must be **modeled** - changes of the % of layers reduce the **accuracy** - **moisture** influence	▪ **Surface** measurement, - **surface** must be representative - **weak** moisture influence on low elements as Na to Si

▪ **Dependent** on the **load** (on belts the load is below the saturation volume) - **overload** - reduced accuracy - **underload** - reduced accuracy	▪ **Independent** of the load
▪ **Large samples** for static calibration are required	▪ **Small samples** for static calibration
▪ **High accuracy** (depending on the application)	▪ **High accuracy** (depending on the application)

Tab. 1: Comparison between PGNAA and XRF

The XRF method gives similar information as the one given by PGNAA systems.(Prompt Gamma Neutron-Activated Analysis) for all elements with an atomic number > 10. However, the investment and maintenance costs of the PGNAA analyzers are much higher than for the OXEA® devices. (the californium sources must be exchanged every two years) Tab. 1 shows the main differences between the XRF and the PGNAA technology.

The method used for the OXEA® product line is multiple patented or applied as patent.

OXEA® 1000 to OXEA® 3000

The instruments OXEA® 1000 to OXEA® 3000 are products of the OXEA® - thousand-line. An Upgrade from OXEA® 1000 to OXEA® 2000 or OXEA® 3000 is possible belatedly. A constant distance of ca. 10-20 mm is necessary between the detector and the surface of the product. Hereby a smooth surface is needed an therefore the maximal particle size is limited to about 50 mm (2″) and the average is limited to < 25 mm (< 1″) .

To meet this distance at a conveyor belt with a varying load, the XRF analyzer is installed on a sled, which slides on the surface of the product (Fig. 4). If necessary, the surface of the material must be flattened, that the sled runs smoothly.

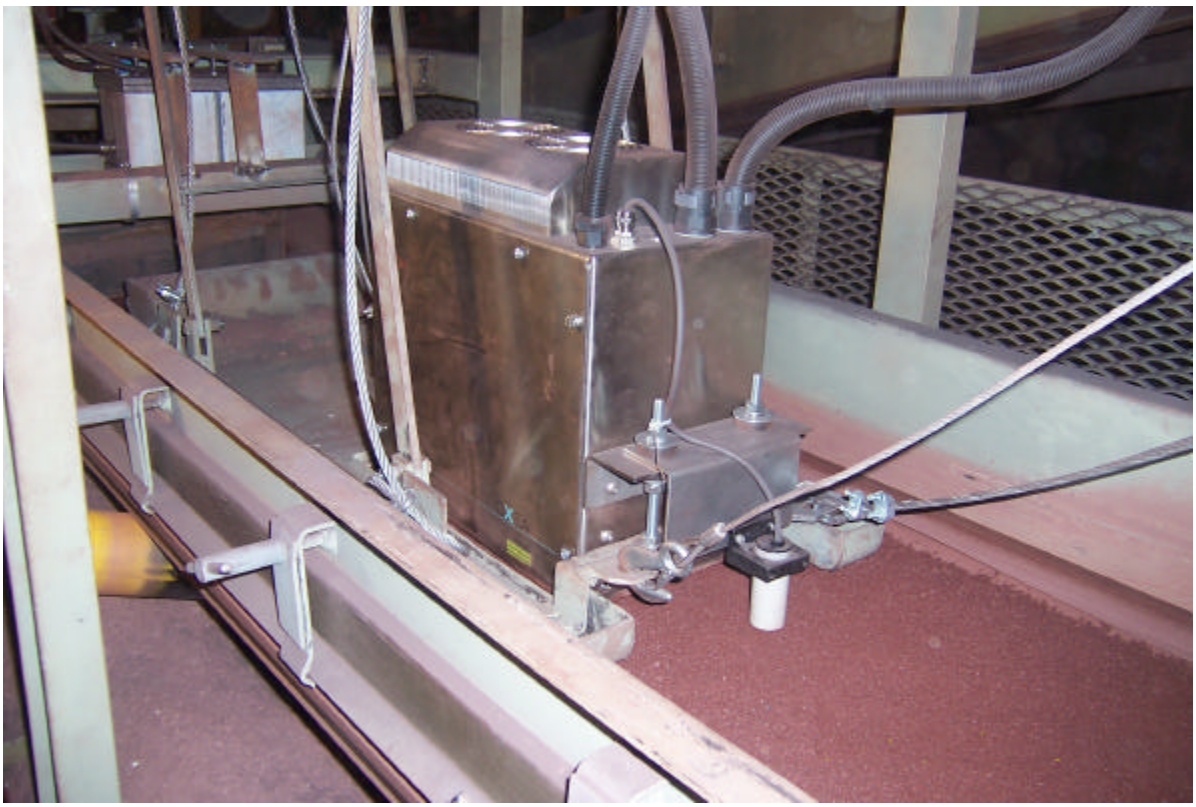

Fig. 4: Sled installation at a main belt

If these conditions cannot be achieved at the main belt, the instruments are to be installed at a bypass belt. The sample material, taken from the main stream is crushed down and the material is prepared on the bypass belt to get optimal measuring conditions. Fig. 5 shows an OXEA® 3000 at a bypass belt. Here a constant layer thickness is guaranteed by a scraper. The instrument is installed in a fixed position over the belt. Of course, also at the bypass belt a sled can be installed.

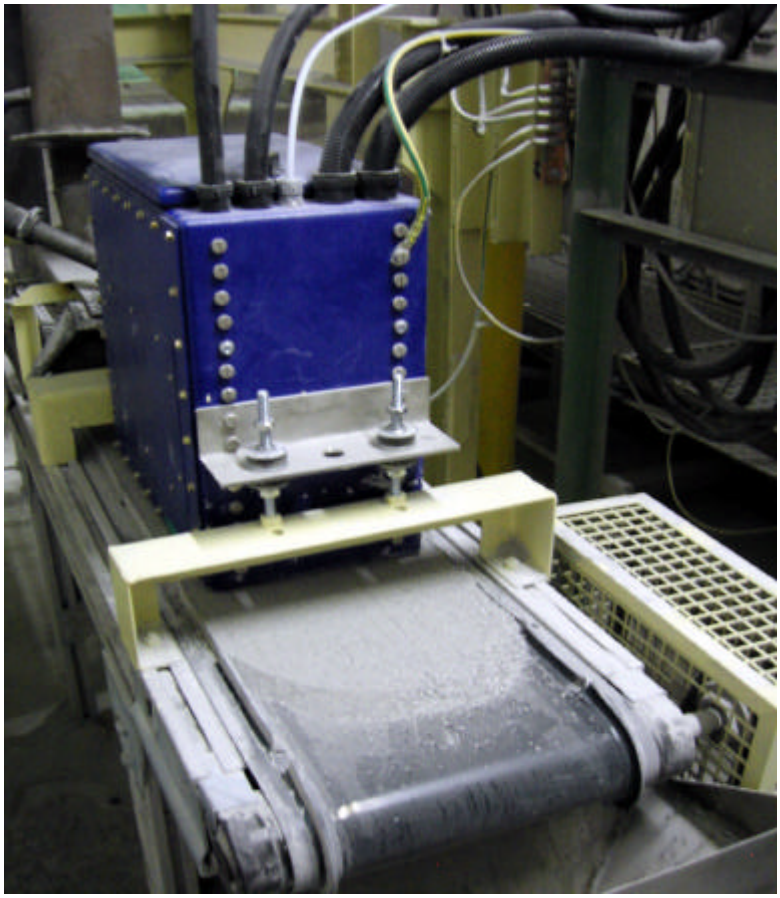

Fig. 5: OXEA® 3000 at a bypass belt

In Fig. 6 the measuring principle of the OXEA® 1000 line is shown as bypass installation. The plough generates a constant layer thickness and a flatten surface.

The Sensor Unit with X-ray tube and Detector is installed over the conveyor belt. In the High Voltage Supply Unit the High Voltage for the X-ray tube is generated. Here also the safety circuits and the routing of several signals is done. The detector signal is connected to the multichannel analyzer MCA. The material sensor detects the presence of material and switches the measurement off, if the belt is empty. The optional installation of the microwave moisture meter PMD 2450 allows to determine the moisture content and the calorific value of coal. The output signals of the PMD 2450 and the MCA are connected to the PC over a serial link (RS 232 or RS 422/485 interface). The PC can be connected to the PLC over Modbus, Profibus etc. to transfer the final results.

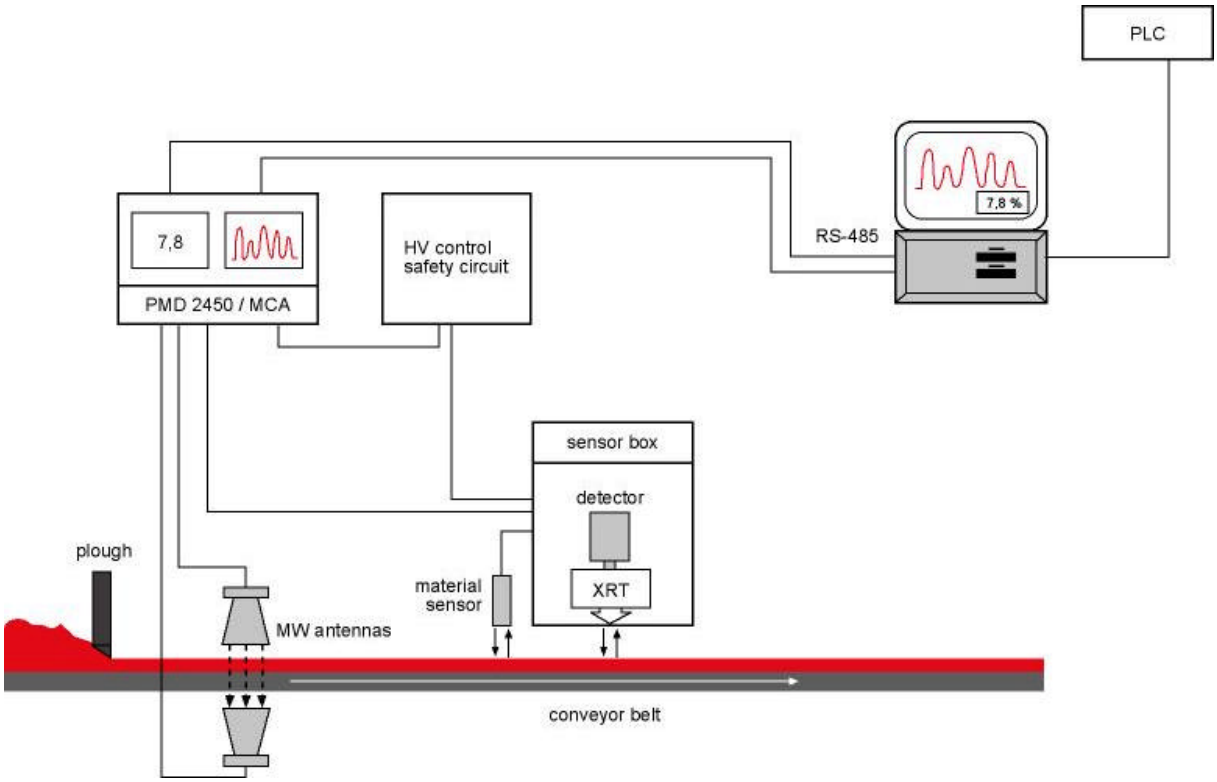

Fig. 6: Measuring principle of the OXEA® 1000 line

Three versions are available within the OXEA® - thousand - line:

OXEA® 1000 Ashmeter, Single Channel Analyzer
OXEA® 1000 is an ash meter with internal iron and calcium compensation. In addition to the backscatter signal the XRF signals are used to improve the accuracy, especially to compensate for variations of the iron and calcium content of the ash. The obtainable accuracy is much higher than with the Dual Energy method.

For non-coal applications the OXEA® 1000 allows a single channel measurement, i.e. the detection of one element.

OXEA® 2000 Ash- and Sulfur Analyzer
OXEA® 2000 enables the determination of the sulfur in addition to the ash content. Measuring set-up and installation conditions are the same as for the OXEA® 1000. For non-coal applications the OXEA® 2000 allows a two channel measurement, i.e. the detection of two elements.

OXEA® 3000 Elemental Analyzer
In addition to the ash- and sulfur content OXEA® 3000 enables to determine the elemental composition of the ash for all elements with an atomic number >10. In specific cases also sodium can be determined. The measurement covers also trace elements as As, Hg and Pb. The limit of detection depends on the matrix and must be proved in particular cases and is typically in the range of 20 -200 ppm. Furthermore OXEA® 3000 allows to determine other specific coal parameters as the volatiles and the ash fusion and to distinguish between coal of different origin or if another material is on the belt as coke, petrolcoke or slag. For non-coal applications the OXEA® 3000 allows a multi channel measurement, i.e. the detection of an unlimited number of elements.

Measuring set-up and installation conditions are the same as for the whole OXEA® - thousand - series.

OXEA® atline

The instruments OXEA® 1000 to OXEA® 3000 are also available as atline version for fast offline measurements. The measuring result is available within 2-3 minutes. A license as fully covered system is applied. With this license the OXEA® atline (Fig. 7) can be used without individual licensing and without radiation protection officer.

Fig. 7: OXEA® atline

OXEA® 500 Over belt Analyzer

The OXEA® 500 line measures contactless a material with a particle size < 75 mm - 100 mm (3 ” - 4”) directly on the main belt without sampling system and bypass belt. Elements with an atomic number Z > 19 can be determined. Fig. 8 shows the measuring principle of the OXEA® 500 line. The sensor installed over the conveyor belt in an distance between 8 and 25 cm. A delimiter for cutting the maximal layer thickness and a scraper for smoothing the material surface before the measuring point are advantageous. The distance is determined with an ultrasonic sensor for a distance compensation of the measuring signal.

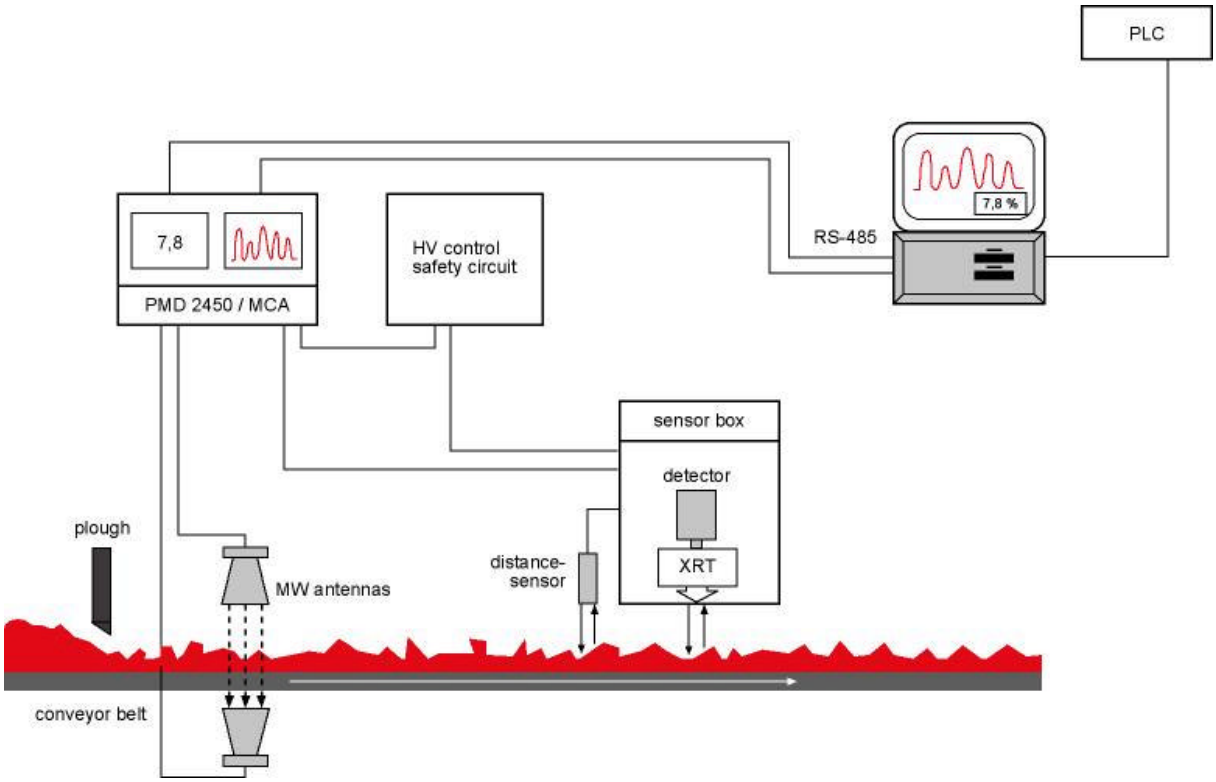

Fig. 8: Measuring principle of the OXEA® 500 line

The instrument is available in two versions:

OXEA® 500-1 Over Belt Ash Meter / Single Channel Elemental Analyzer
The ash content is determined by using the backscatter technique in combination with an X-ray fluorescence measurement for iron and calcium compensation. As source an X-ray tube is used. Because only elements with an atomic number >19 can be measured sulfur cannot be detected.

For non-coal applications the OXEA® 500-1 allows a single channel measurement, i.e. the detection of one element with an atomic number Z > 19.

OXEA® 500-3 Over Belt Ash Meter / Multi Channel Elemental Analyzer
In addition to the ash content OXEA® 500-3 enables to determine the concentration of elements with an atomic number >19. A measurement of trace elements as As, Hg and Pb is also possible.

OXEA® 600 (GTA 3000) line: Over-belt XRF-Gamma-Transmission-Analyzer
A rough surface of the material reduces the accuracy of the backscatter method. For these applications the OXEA® 600 / GTA 3000 line was developed, which combines the dual-energy gamma-transmission method of the GTA line with the over-belt XRF method of the OXEA® 500. Fig. 9 shows the measuring principle of the OXEA® 600 / GTA 3000. Under the belt opposite to the X-ray tube a detector is installed, which measures the transmission of the X-rays according to the GTA 1000-2. Of course, also an additional Am-241 source can be used for the transmission measurement according GTA 1000-1. The Cesium transmission line of the GTA series is part of this system too. In the measuring principle of Fig. 9 this signal is additionally used for the distance compensation of the XRF measurement. This is possible, if the density of the material is constant. Alternatively an additional ultrasonic distance sensor can be

used, as shown in the scheme of the OXEA® 500. The OXEA® 500 is completely a part of the OXEA® 600.

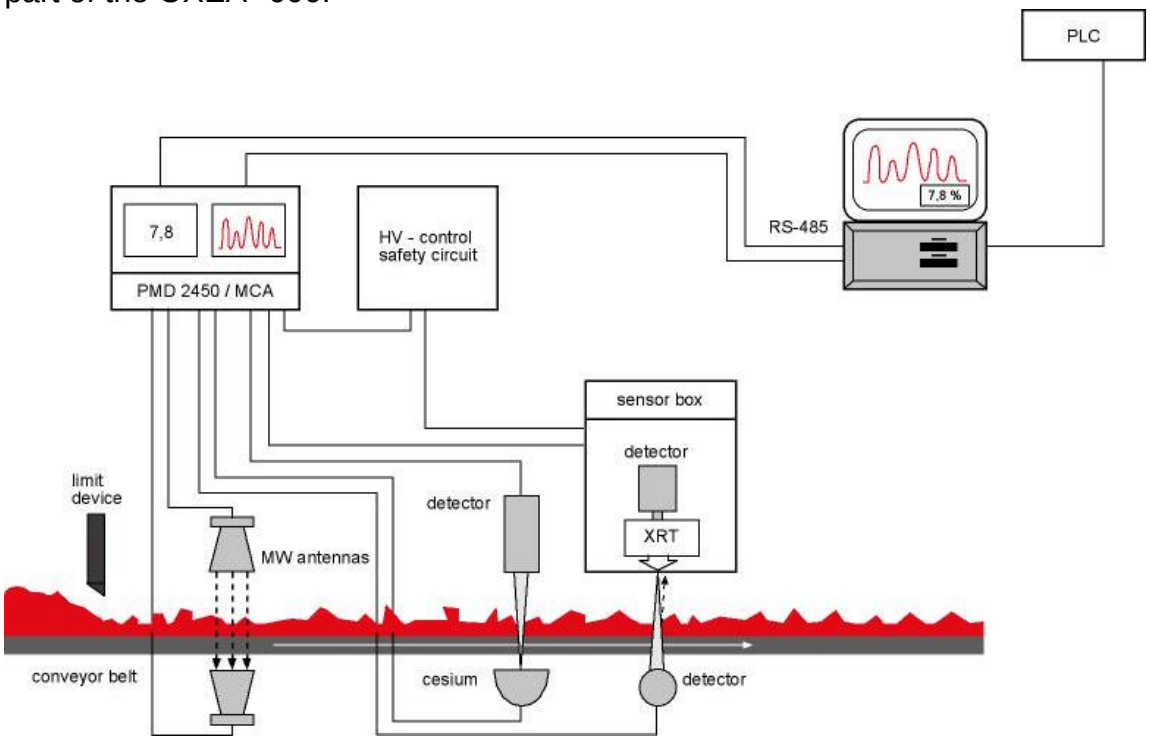

Fig. 9: Measuring principle of the OXEA® 600 (GTA 3000) line

Because of this combination the limitations of both the GTA line and the OXEA® 500 are to be considered: The minimal layer thickness is 5 cm. The maximal layer thickness is, depending on the low energy gamma transmission sourceor X-Ray energy, between 15 and 25 cm. The distance between the XRF detector and the material surface is between 7 and 25 cm. The particle size is limited to < 75 -100 mm (3" - 4").

The instrument is available in two versions.

OXEA® 600-1 Over Belt Ash Meter

The ash content is determined by using the dual energy gamma transmission technique in combination with an X-ray fluorescence measurement for iron and calcium compensation. As high energy source Cs-137 is used. As low energy source it can be selected between Am-241 and the X-ray tube. Because only elements with an atomic number >19 can be measured, sulfur cannot be detected.

OXEA® 600-3 Over Belt Ash Meter / Multi Channel Elemental Analyzer

In addition to the ash content OXEA® 600-3 / GTA 3000 enables to determine the concentration of elements with an atomic number >19. A measurement of the trace elements as As, Hg and Pb is also possible within the limit of detection.

Moisture Content and Calorific Value

Each of these ash analyzers combined with the microwave moisture meter PMD 2450 enables to determine additionally the moisture content and the calorific value of coal.

The following table gives an Overview of Indutech´s Various Models of Online Ash Analyzers.

Overview of Indutech Ash Analyzers

Type	Measuring Principle	Measured Parameter	Advantage	Limitation
GTA 1000-1	Dual Energy Gamma Transmission with Cs-137 and Am-241 as sources	ash content	contactless low cost	particle < 300 mm influence of elemental composition
GTA 1000-2	Dual Energy Gamma / X-ray Transmission with Cs-137 and an X-ray tube as sources	ash content	contactless improved accuracy compared to GTA 1000-1	particle < 300 mm influence of elemental composition
GTA 2000	Triple Energy Gamma / X-ray Transmission with Cs-137, Am-241 and X-ray tube	ash content	contactless iron compensation	particle < 300 mm other elements as Ca must be constant
OXEA 500-1 2 pending patents	XRF / backscatter over belt ash analyser	ash content	contactless compensation of elemental ash composition	particle < 75-100 mm (3" - 4") distance to surface 70 - 230 mm
OXEA 500-3 2 pending patents	XRF / backscatter over belt ash analyser	ash content elemental composition of ash for elements with Z > 19 (Potassium)	contactless compensation of elemental ash composition	particle < 75-100 mm (3" - 4") distance to surface 70 - 230 mm
GTA 3000-1 / **OXEA 600-1** 3 pending patents	Dual Energy Gamma Transmission + OXEA 500	ash content	contactless compensation of elemental ash composition improved accuracy compared to OXEA 500-1	particle < 75-100 mm (3" - 4") distance to surface 70 - 230 mm
GTA 3000-3 / **OXEA 600-3** 3 pending patents	Dual Energy Gamma Transmission + OXEA 500	ash content elemental composition of ash for elements with Z > 19 (Potassium)	contactless compensation of elemental ash composition improved accuracy compared to OXEA 500-3	particle < 75-100 mm (3" - 4") distance to surface 70 - 230 mm
OXEA 1000 patented 3 pending patents	XRF / backscatter	ash content elements with Z > 10	compensation of elemental ash composition best accuracy	particle size max . < 50 mm, avg.< 25 mm distance to surface ~20 mm sled or bypass belt application
OXEA 2000 patented 3 pending patents	XRF / backscatter	ash sulphur elements with Z > 10	compensation of elemental ash composition best accuracy	particle size max .< 50 mm, avg.< 25 mm distance to surface ~20 mm sled or bypass belt application
OXEA 3000 patented 3 patents pending	XRF / backscatter	ash, sulphur, volatiles, ash fusion, type recognition elemental ash composition (Z > 10)	compensation of elemental ash composition best accuracy	particle size max .< 50 mm, avg.< 25 mm distance to surface ~20 mm sled or bypass belt application

All ash analyzers can be equipped with our PMD 2450 Microwave Moisture Meter to determine the Moisture Content and Calorific Value in addition to the Ash Content.

OXEA® 1000 to OXEA® 3000 can be delivered:

- as atline version to measure samples in the laboratory or in the field within 3 minutes
- with optional type recognition and automatic switching of calibration parameters

Measuring Equipment for the Coal and Mineral Industry

- measurements made on:

- main belt
- bypass belt
- atline (near process)

advantages of OXEA® - online XRF Elemental Analyzer

- low license procedure
- no costs for disposal of nuclear waste
- low maintenance costs
- remote maintenance
- self-check function
- continuous data transfer to the PC and PLC

available measuring parameters

- ash content
- sulphur content
- trace elements, e.g. arsenic
- complete elemental composition of ash
- ash fusion
- volatiles
- calorific value
- recognition of the different coal types
- determination of coal / coke / slag / petrol coke
- elemental composition of minerals
- elemental composition at high temperatures, e.g. converter dust with up to 350°C

advantages of PMD 2450 - **P**recision **M**icrowave **D**etector

- accurate contactless online moisture measurement
- no nuclear sources in most applications
- data collection over 1 year
- continuous data monitoring and data transfer to PLC

available measuring parameters

- moisture
- density / concentration of slurries
- carbon in fly ash

you will find InduTech measurements in

- mines
- coal-fired power plants
- coking plants
- preparation plants
- steel plants
- cement industry
- others