Application Note EDXRF1858

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EDXRF1858 - P_2O_5 & K_2O in Fertilizers

Scope

The measurement of phosphorus (P_2O_5) and potassium (K_2O) by empirical calibration is demonstrated. The Fundamental Parameters (FP) is also demonstrated to include the screening of minor elements when no or only a few reference standards are available for calibration using Rigaku Matching Library.

Background

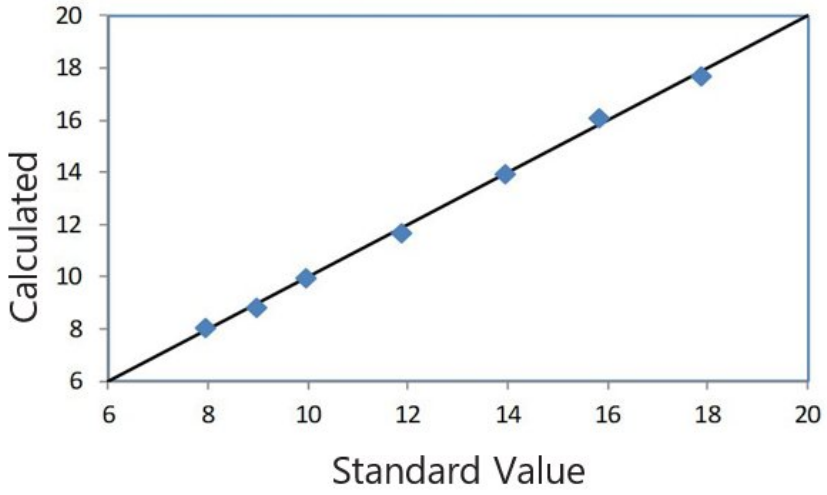
The primary nutrients in fertilizers are nitrogen, phosphorus, and potassium (NPK). While XRF does not measure the nitrogen, it is an ideal tool to measure and control the proper levels of phosphorus (as P_2O_5) and potassium (as K_2O) in the production of fertilizers. Using a one-time calibration, the measurement is direct and simple, allowing for high sample throughput and batch analysis. The Rigaku NEX QC Series are ideal systems for at-line quality control checks, in the QC lab and for researchers alike. Use standalone models with touchscreen interface or add the PC-based QuantEZ software for more detailed analysis using Fundamental Parameters.

Empirical calibrations

A small suite of 7 standards with known values from a referee technique (ICP) was used for calibration. The best-fit regression empirical approach is the most accurate for a given formulation to ensure proper control and balance of the PK components.

Empirical calibrations — P_2O_5

Element: P Units: %		
Sample I.D.	**Standard value**	**Calculated value**
1	7.93	8.06
2	8.96	8.86
3	9.95	9.94
4	11.85	11.71
5	13.92	13.97
6	15.82	16.07
7	17.86	17.69

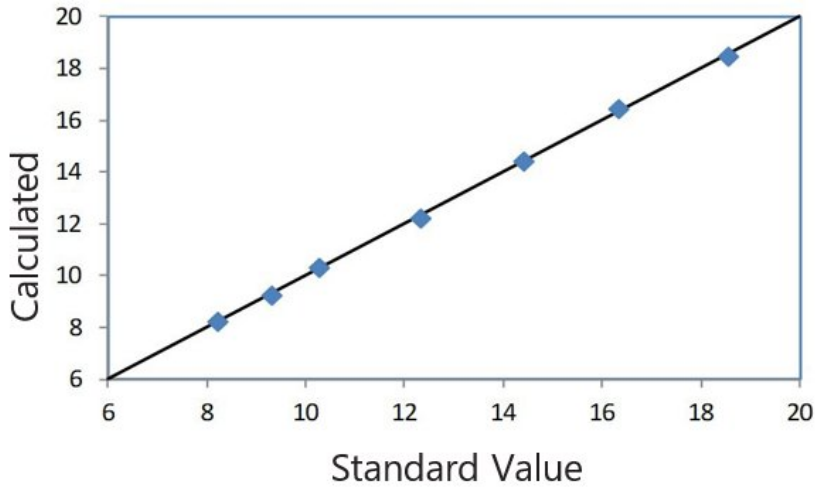


Correlation plot P_2O_5 in fertilizers

Empirical calibrations — K_2O

Element: K Units: %		
Sample I.D.	**Standard value**	**Calculated value**
1	8.23	8.27
2	9.32	9.24
3	10.26	10.35
4	12.31	12.20
5	14.42	14.43

6	16.34	16.45
7	18.55	18.49



Correlation plot K_2O in fertilizers

Repeatability (precision)

To demonstrate effective recovery and repeatability (precision), representative low and high concentration calibration standard samples were analyzed as unknowns. 10 repeat analyses are taken of each sample with results summarized below.

Sample ID: 1				**Units: Mass%**
Component	**Standard value**	**QuantEZ value**	**Std. deviation**	**RSD (%)**
P_2O_5	7.93	8.10	0.0050	0.06
K_2O	8.23	8.27	0.0397	0.48

Sample ID: 6				**Units: Mass%**
Component	**Standard value**	**QuantEZ value**	**Std. deviation**	**RSD (%)**
P_2O_5	15.82	15.98	0.0344	0.21
K_2O	16.34	16.56	0.0644	0.39

Fundamental parameters (FP)

This demonstration shows the measurement of the PK components and the trace elements S, Zn, and Rb using FP. A standardless semi-quant FP method was developed using the QuantEZ method template for Water. The semi-quant method is excellent for screening and comparative investigation without the need for any assayed reference standards. The FP method was further optimized through the simple creation of Rigaku Matching Library using 3 samples that had

been assayed by ICP for P_2O_5, K_2O, S, Zn, and Rb. A Matching Library is easily created by the user and is used in conjunction with the standard FP library in the modeling of a sample matrix and calculation of concentration results. This allows for a quantitative measurement of elemental concentrations without the need for a large suite of known assayed calibration standards.

Two unknown samples were then measured using Rigaku NEX QC+ QuantEZ and ICP, the results are shown here.

Sample ID: Unknown A **Units: P, K (%); S, Zn, Rb (ppm)**			
Component	**QuantEZ value**	**ICP value**	**Stat. error**
P_2O_5	18.71	18.60	0.02
K_2O	6.30	6.22	0.03
S	12728	13008	22
Zn	641	680	2
Rb	9.4	—	0.1

Sample ID: Unknown B **Units: P, K (%); S, Zn, Rb (ppm)**			
Component	**QuantEZ value**	**ICP value**	**Stat. error**
P_2O_5	19.36	19.15	0.02
K_2O	2.91	3.14	0.02
S	ND*	—	6
Zn	87.2	—	0.8
Rb	6.6	—	0.1

Conclusion

The results shown in these demonstrations show the versatility of the NEX QC Series product line. From stand-alone touchscreen systems for at-line quality checks to the addition of QuantEZ PC-based software, the EDXRF systems from Applied Rigaku Technologies are ideal tools for the production control, screening, and comparative research work in the manufacturing of fertilizers.

Related products

NEX QC Series

Combines quality, affordability, and performance for a wide range of applications