



# THE PRODUCTION OF SUSPENDED FERTILIZERS BASED ON ASHES FROM COMBUSTION OF SEWAGE SLUDGE WITH THE USE OF PHOSPHATE SOLUBILIZATION WITH BACILUS MEGATERIUM BACTERIA

MACIEJ ROLEWICZ<sup>1</sup>, MICHAŁ DAWIDOWICZ<sup>1</sup>, PIOTR  
RUSEK<sup>1</sup>, BARBARA CICHY<sup>2</sup>, SEBASTIAN SCHAB<sup>1</sup>

<sup>1</sup>NEW CHEMICAL SYNTHESIS INSTITUTE, PUŁAWY

<sup>2</sup>NEW CHEMICAL SYNTHESIS INSTITUTE, INORGANIC  
CHEMISTRY DEPARTMENT "ICHN", GLIWICE

# NEW CHEMICAL SYNTHESSES INSTITUTE

## BUSINESS PROFILE

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- Inorganic synthesis and technology
- Technology of mineral fertilizers
- Biotechnology
- Applied catalysis, catalysts and sorbents
- Environmental protection



# FERTILIZERS DEPARTMENT

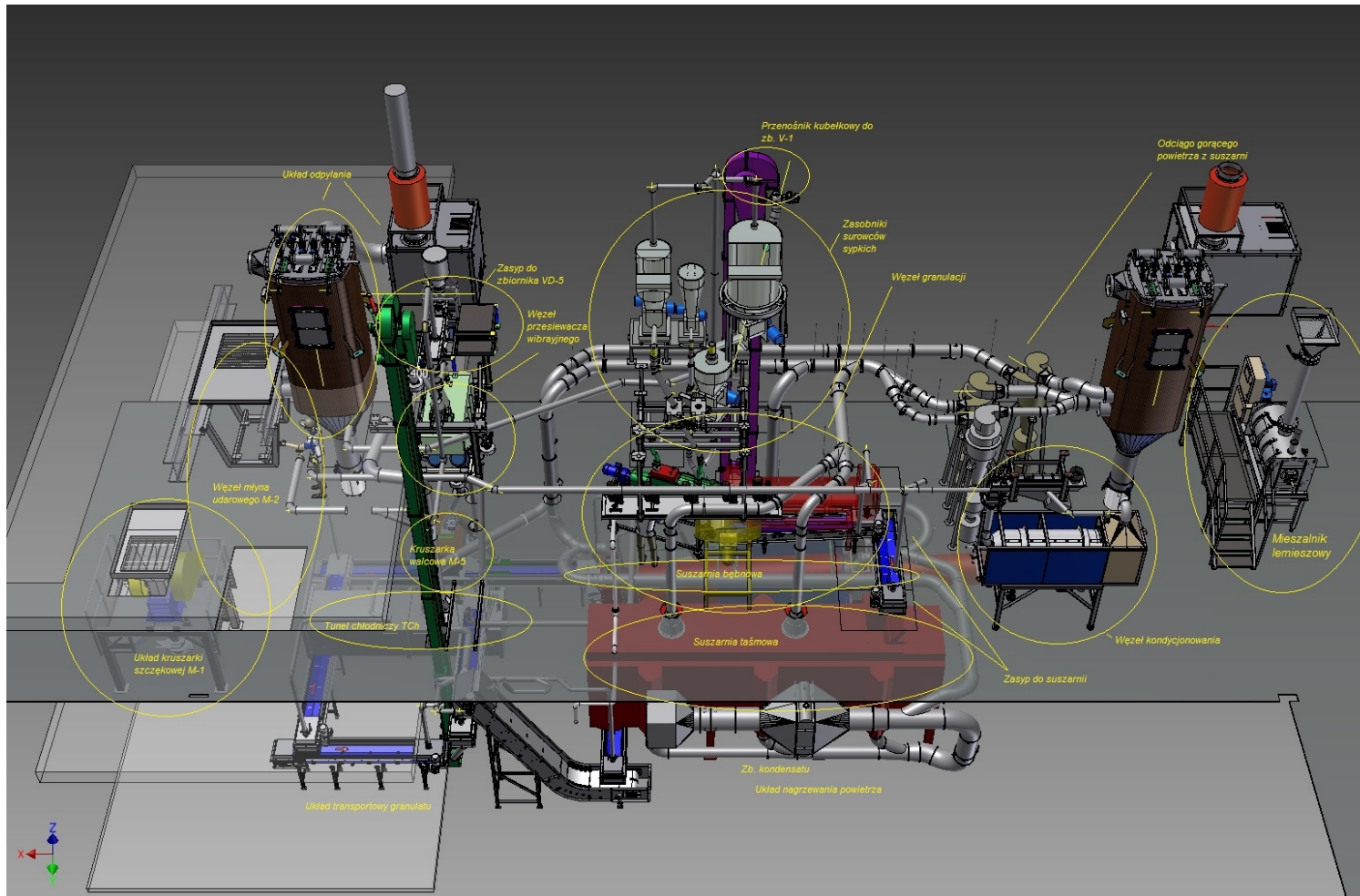
## FERTILIZERS RESEARCH CENTER

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- Mineral and mineral-organic fertilizers
- Processes and unit operations with particular focus on various methods of granulation
- Industrial and municipal waste management for fertilizers production
- Designing of new technological processes, selection of devices and industrial equipment, participation in start-up of new plants
- Research services covering the study of the raw materials and by-products properties for the fertilizers production and evaluation of physicochemical properties of fertilizers



# A PILOT PLANT FOR FERTILIZER GRANULATION RESEARCH



# GRANULATION NODES





# DRYING AND COOLING NODES



# REACTION NODES





# A PILOT PLANT FOR LIQUID (CLEAR AND SUSPENSION) FERTILIZERS RESEARCH





# LABORATORIES

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- **Laboratory of Fertilizers Physicochemical Properties Evaluation:** determination of strength, abrasion resistance and susceptibility to caking, sieve analysis, determination of moisture content
- **Liquid Fertilizer Laboratory:** viscosity measurements, particle size distribution tests, determination of crystallization temperatures
- **Laboratory of Fertilizer Granulation Processes Research:** studies on the granulation of various kinds of fertilizer raw materials, the technological for conducting pilot-scale processes
- **Laboratory of In-Line Analyses:** analysis of the chemical composition of fertilizers and raw materials
- **Laboratory of Thermal Analyses:** evaluation of process safety in fertilizers manufacture with the new fertilizers compositions and different types of materials, quality determination of fertilizer products





# **WHAT IS THE PROBLEM?**

# THE WORLD'S FERTILIZERS DEMAND IN THE YEARS OF 2012-2016 (THOUSANDS TONES OF THE COMPONENT)

Year	2012	2013	2014	2015	2016
N	109 928	111 558	113 063	114 504	115 956
P <sub>2</sub> O <sub>5</sub>	41 525	42 731	43 487	44 251	45 013
K <sub>2</sub> O	28 626	29 494	30 879	32 208	33 163





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# **PHOSPHORUS RECYCLING?**

**YES!!!**

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# ASH FORMED AFTER BURNING SLUDGE FROM WATER TREATMENT PLANT IN ŁYNA NEAR TO OLSZTYN, IN POLAND



# ASH CHARACTERISTICS

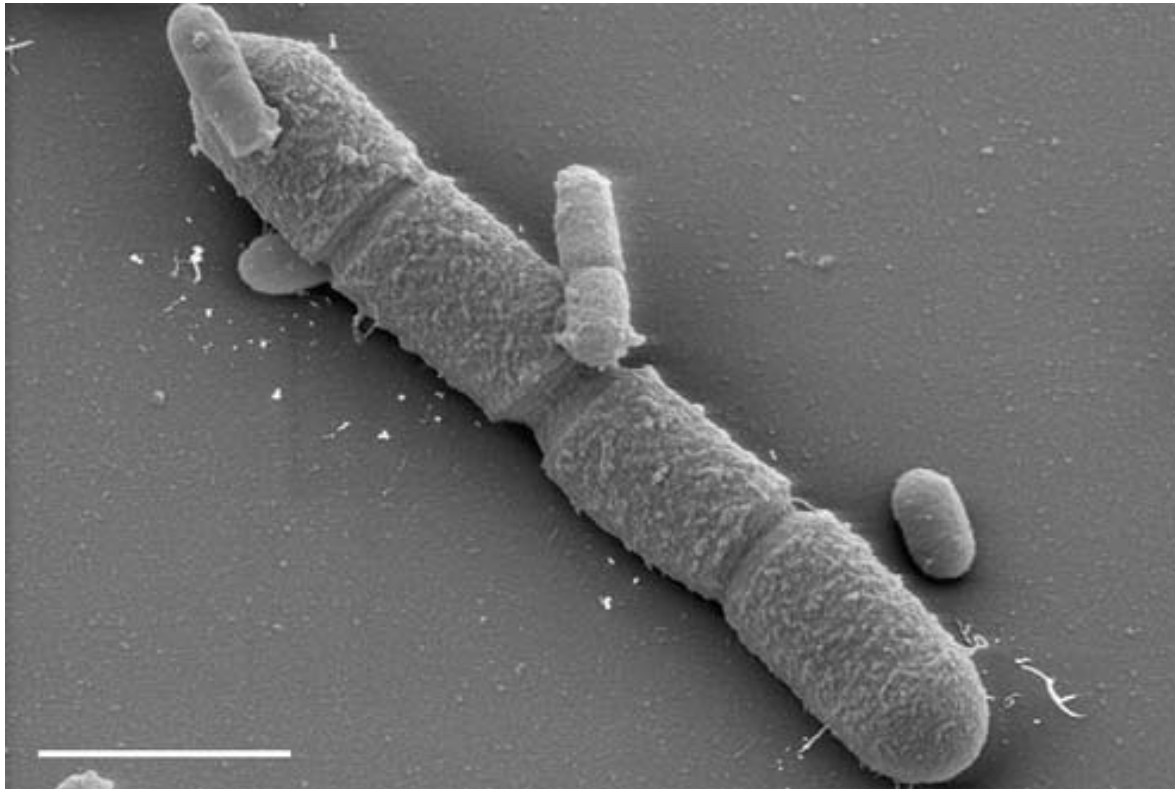
<b>P<sub>2</sub>O<sub>5</sub> Form</b>	<b>Content in ash, wt. %</b>	<b>Content in phosphate, wt. %</b>
<b>Total</b>	24,7	32,4
<b>Soluble ammonium citrate</b>	7,2	1,3
<b>Soluble in water</b>	Below the determination limit	0,5





# BUT HOW?

By using bacillus megeterium bacteria



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## Laboratory scale

Phosphate source:

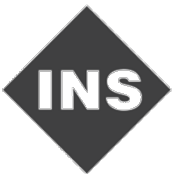
- Ash from Łyna
- Phosphoresce Marocco as a control

Temperature of the process

- 35°C

Time of process:

- 7 days



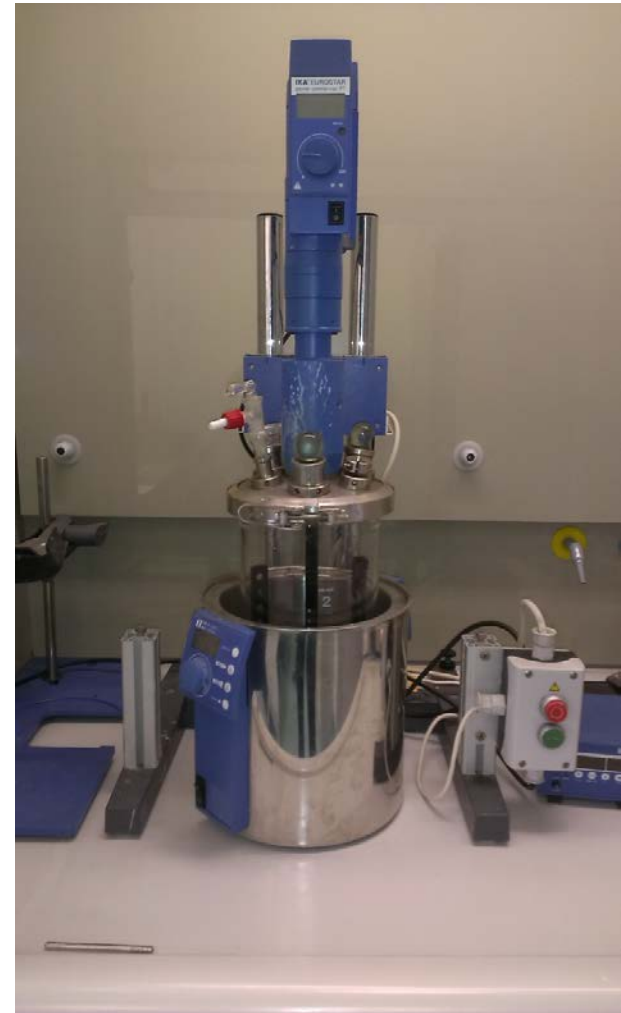
# IKA LABORATORY REACTOR

The laboratory tests were performed in a IKA LR-2. ST Package with EUROSTAR stirrer.

Volume of reactor 1,5 liter

The reactor is capable of measuring and recording the following parameters: temperature, spin speed, torque.

Process without and with aeration





# BACILLUS MEGATERIUM NUTRIENT:

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Glucose - 10 g/l

Ammonia sulfate(VI) - 0,5 g/l

Sodium chloride - 0,2 g/l

Heptahydrate magnesium sulfate(VI) - 0,1 g/l

Potassium chloride - 0,2 g/l

Monohydrate manganese sulfate(VI) - 0,002 g/l

Heptahydrate iron sulfate(VI) - 0,002 g/l

Yeast extract - 0,5 g/l

Calcium phosphate - 2,5 g/l



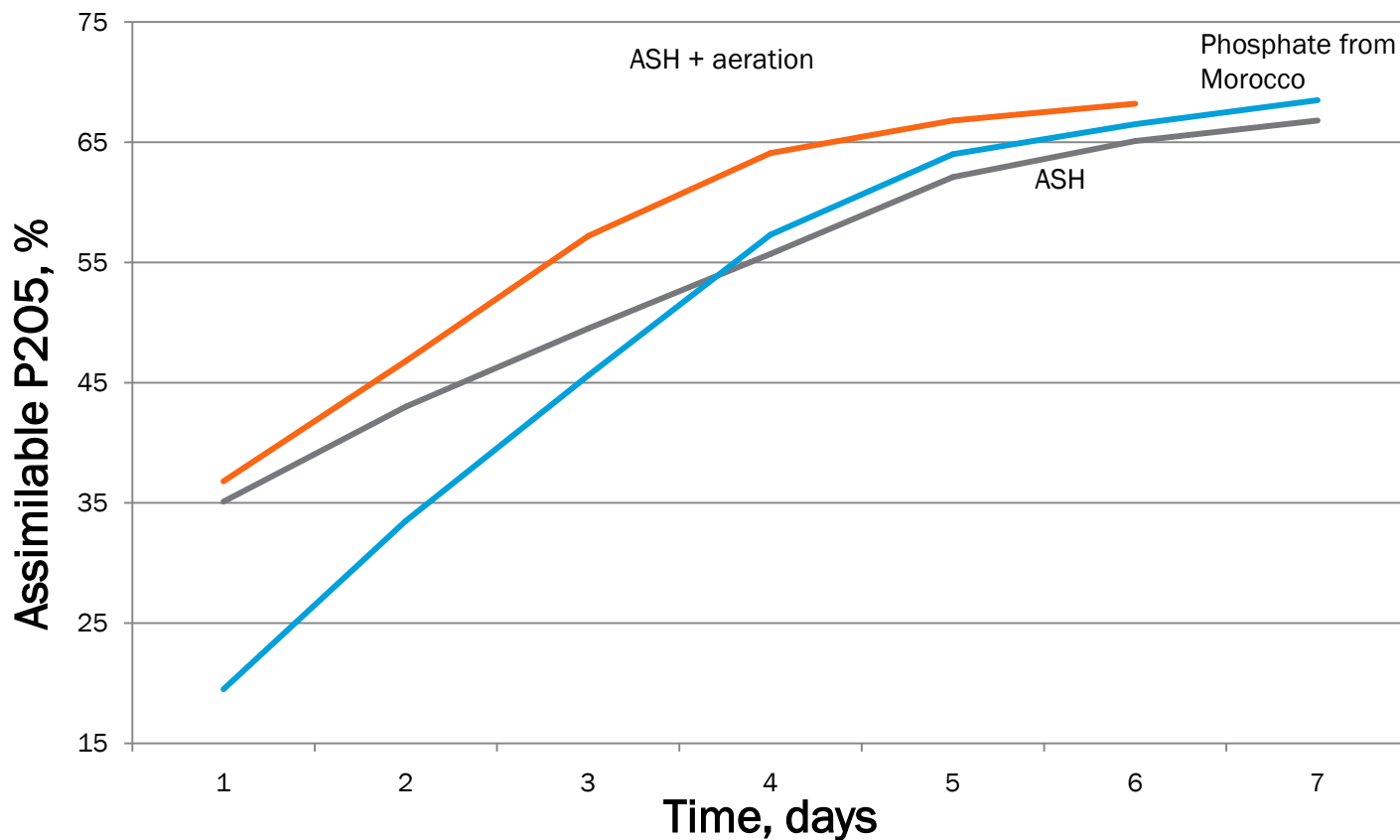
# MEASURING METHODS

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- Determination of total phosphates was conducted by a gravimetric method with the use of quinoline phosphomolybdate according to Regulation (EC) nr 2003/2003.
- Determination of assimilable phosphates, soluble in 2% citric acid was also conducted by a quinoline-molybdate gravimetric method. The determinations were preceded by an extraction conducted with a 2% citric acid. The extraction was proceeded according to Regulation (EC) 2003/2003.
- Determination of phosphates soluble in water was conducted by a spectrophotometer method with the use of phosphomolybdate blue and conducted with a Jenway 6300 spectrophotometer.
- The pH measurement of the reaction mixture was conducted with the use of an Elmetron CX-501 multifunctional PH meter.

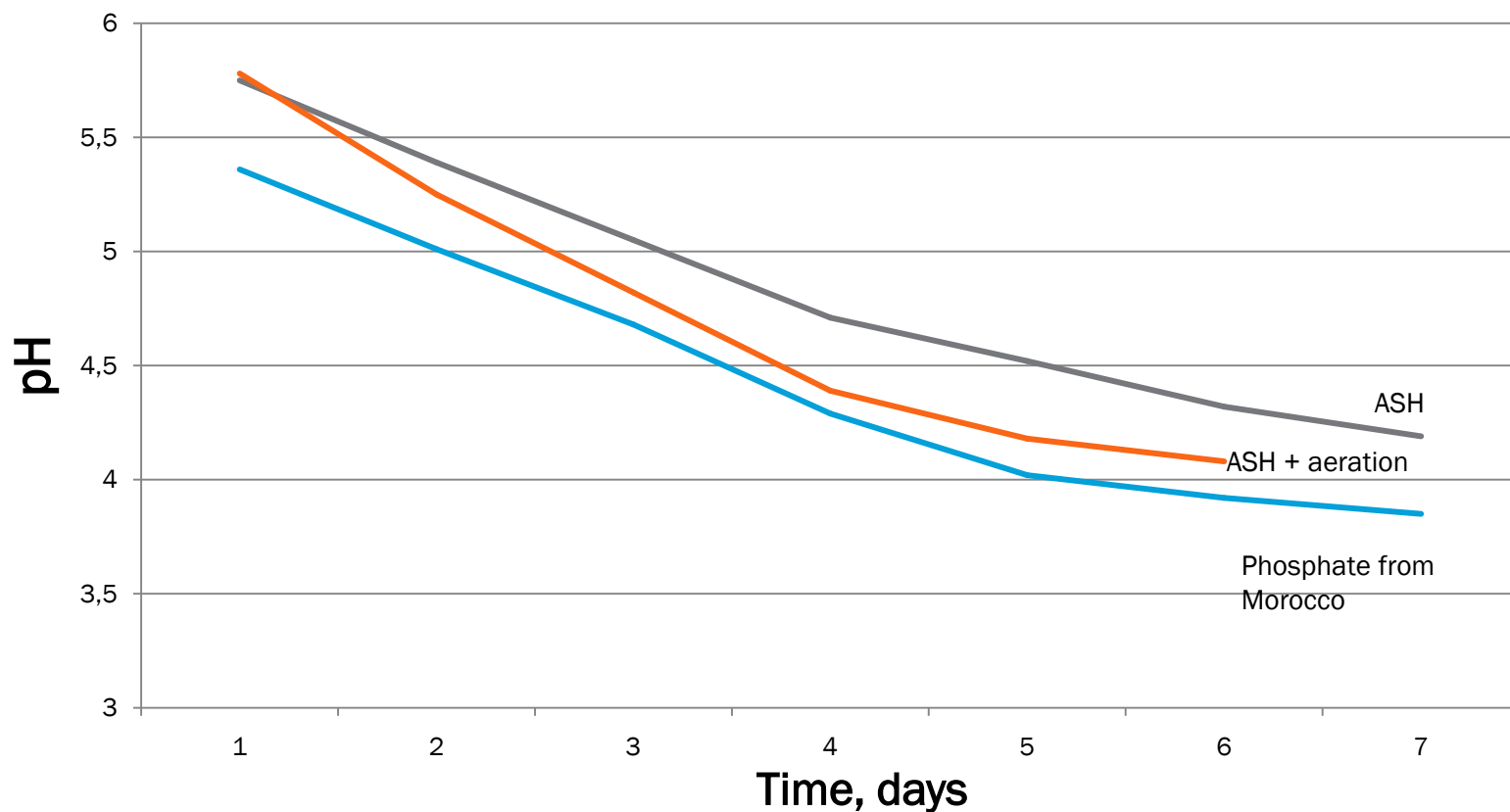
# LABORATORY RESULTS

Changes in the content of assimilable P2O5 to total P2O5 in fertilizer suspension on the basis of *Bacillus megaterium*.



# LABORATORY RESULTS

Change of pH during the process for preparing suspension fertilizers based on *Bacillus megaterium*.



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- Approx. 2/3 of P<sub>2</sub>O<sub>5</sub> in the form of absorbable for plants
  - Additional aeration of the mixture accelerates the achievement of the optimum degree of conversion of digestible forms of phosphorus for plants



# PILOT-PLANT SCALE TESTING



Volume of the reactor

- 100 L

Temperature of the process

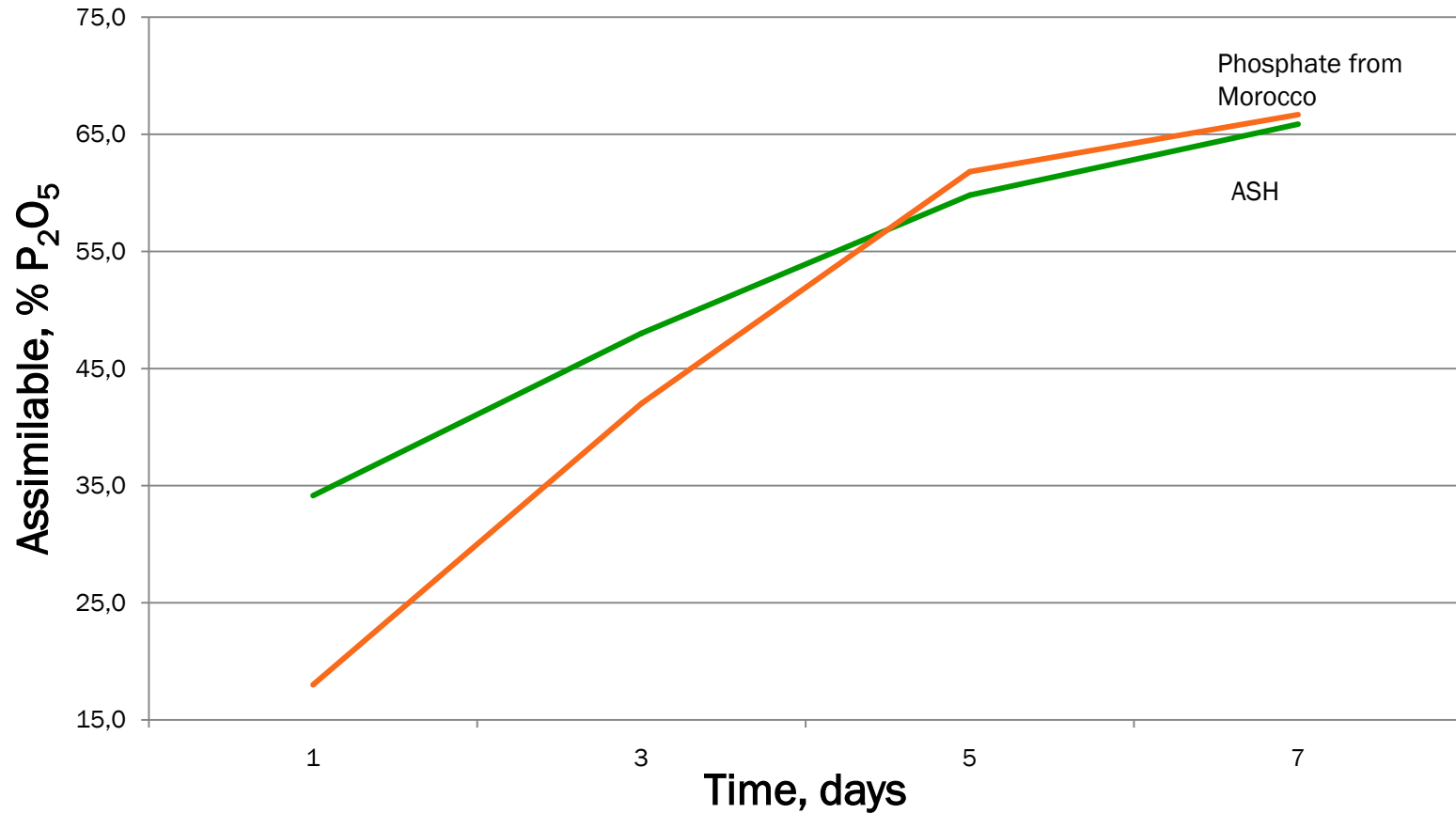
- 35°C

Time of the process

- 7 days

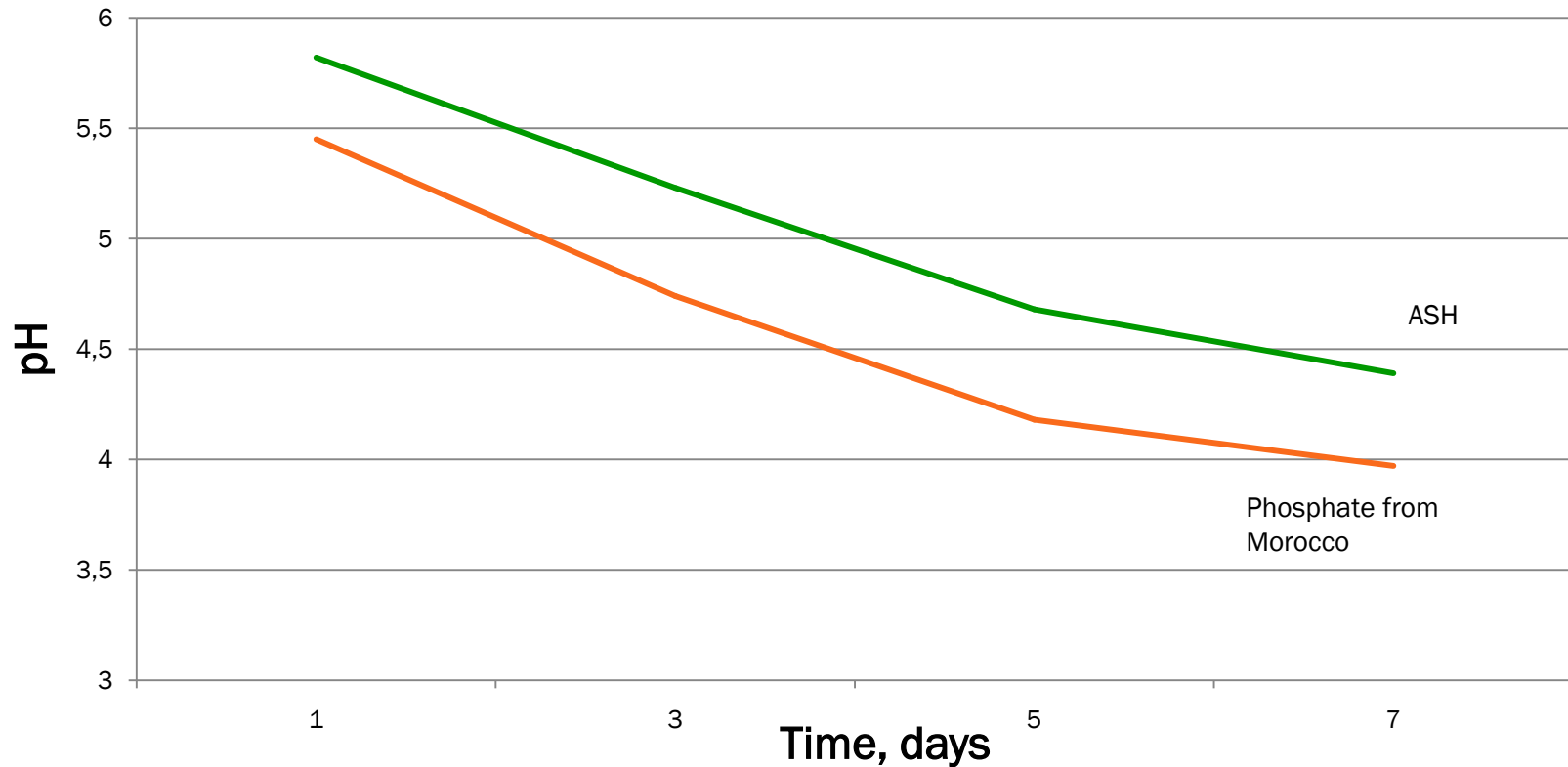
# RESULTS

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# STABILIZATION OF SUSPENSION

7% of bentonite  
After 2h the suspension  
dropped



Additional grinding of ash

- 100 microns
- 200 microns

Quantity of bentonite

- 7,5%
- 10%
- 12,5%



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# CONCLUSIONS

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- Experiments have confirmed that it is possible to produce suspended phosphate fertilizers of the waste products, using the solubilization of phosphorus by *Bacillus megaterium* bacteria, and that to operate the process is not complicated.
- A problem of low stability of the obtained suspension was revealed during the research. In order to reduce delamination it is necessary to suitably grind the ash and add a sufficiently large amount of bentonite.
- The next stage of research aimed at assessing the suitability of phosphoric fertilizer suspension should be conducting field trials that will assess the impact of such fertilizers on crop yield.



**THANKS TO:**

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The logo consists of a dark grey diamond shape with the letters "INS" in white, bold, sans-serif font inside it.

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