LOGISTICS OF BULK MATERIALS

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LOGISTIKA SYPKÝCH HMOT

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Abstrakt

Pojem logistika je často reprodukován různými způsoby, speciálně pak definicemi optimalizačních kritérií. Obvykle hovoříme o logistice spojované s oblastí všeobecné technické a ekonomické optimalizace v širším významu. Optimalizace je zaměřena převážně na studium dopravních tras materiálů, informací, energie a finančních toků. Nově se vytvářející oblast logistiky sypkých hmot používá obdobných definic podobně jako jiné oblasti logistiky.

Tento příspěvek formuluje optimalizační kritérium výběhu optimálního typu dopravníku s respektováním mechanických a fyzikálních vlastností určitého dopravovaného sypkého materiálu prostřednictvím nastavení jeho mechanických a fyzikálních vlastností, která jsou vyjádřena pomocí úhlu vnitřního tření. V tomto článku je také zmiňováno nastavování mechanických a fyzikálních parametrů sypkého materiálu za účelem dosažení optimální energetické spotřeby v tomto procesu.

Abstract

The term logistics in technical practice is interpreted in various ways, by means of various definitions especially definitions of some optimization criteria. We talk about logistics of specific technical fields related to their general technical and economical optimization in a broader sense. Optimization is focused mostly on the study of transport routes of materials, information, energy and financial flows. The emerging technical field of *logistics of bulk solids* uses similar terms as other fields.

This paper formulates optimization criterion for a selection of an optimum conveyer with respect to mechanical and physical properties of specific transported bulk material or by means adjusting its mechanical and physical properties expressed via the angle of internal friction. Additional topic here is adjusting mechanical and physical parameters of bulk material to achieve an optimum consumption of energy in this process.

Key words: logistics of bulk material, mechanical and physical properties, optimum consumption energy

1. Introduction

Three attitudes of companies to logistics tasks can be discerned and company structure, production program and strategic goals are important.

1. A firm monotonously produces one type of a conveyer.

This firm risks more than is appropriate to push forward its products on the market and introduces its product even to those fields of bulk material transportation where the product cannot meet an expected function, with an intention that the arising problems will be solved with an extension of the former order. The original equipment is than altered and appended step by step to obey the demanded function up to some customer acceptable limit costs.

2. The firm producing an assortment of products for specific technologies and specific bulk materials - conveyers, processing technological equipment and attendant equipment.

These strictly specialized firms are usually repeatedly solving typical tasks of a specific industry. They specialize to some material type (coal, meal, sugar) and specific technology (transportation, mixing, and disintegration). Such firms are acquiring a huge deal of some progressive „know-how“ to find solutions of tasks of specific industry but without knowing the nature of relevant phenomena and the governing laws. By public *revealing and describing these laws this temporary advantage of such firms looses its value because the know-how becomes available to everybody.

3. A firm supplying complete investments complexes

The firms oriented to complete investment supplies do not limit themselves to their own products of limited conveyer assortment, its own production technology or a specific type of technology. They are able to trim the solution to fulfill a customer's needs.

2. Logistics viewed from the side of bulk material and partial process parameters of transportation

The optimization of bulk material flows is usually searched in constructions, power units, geometry of transportation routes, applied materials, velocities and transport dynamics. Less common and much more demanding is to optimize equipment and its function with respect to mechanical and physical properties of a concrete bulk material. A complex formulation is rather exacting but the most of characteristics can be expressed by a more general quantity and that is the angle of internal friction. If we study material condition in an interval (0°,90°) of the angle of internal friction φ the material shifts from a liquid state across an interval of bulk material to solid materials. To this fact must react even transportation principles in a specific interval of this angle of internal friction. If the selection of transportation principle of bulk material with respect to the angle of internal friction is evaluated, a very strong criterion for the optimization of transportation route, storage and manipulation principle and consequently economy of processes arises.

2.1 Logistics of type and principle of conveyer

A selection of a conveyer principle and transportation strategy influences in fundamental way transportation function and its economy From the point of the angle of internal friction it is adequate to select a specific type of a conveyer which is suitable to a concrete bulk material - Figure 1. This knowledge of the angle of internal friction and its relative stability in a certain range is necessary.

We meet with an occurence of belt or screw conveyers for bulk materials with an angle of internal friction - for example due to processing operations - between 0° and 30° in practice. We can compare this situation to one with usage of belt conveyer for transportation of a mixture of river sand with water - which can be considered rather amusing.

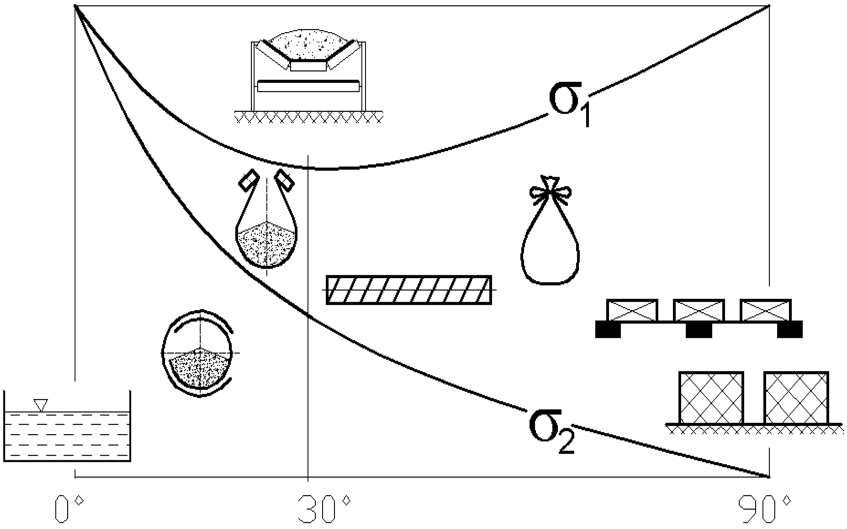

Fig.1 Logistics optimization adjoining the principle of bulk material transportation to the angle of internal friction and behavior of vertical $\sigma_1 \downarrow$ and horizontal $\sigma_2 \rightarrow$ stresses

2.2 Logistics of choice and optimization of closed container for bulk materials

A container shape corresponds to a concrete bulk material nearly explicitly - as far as the angle of internal friction - to ensure the mass flow mechanism. This condition of the mass flow is generally accepted by all container operators. The main role in it plays the container shape, slope of container walls and above all the angle of internal friction of stored material. Small angles of the internal friction allow an application of small slopes of container walls and vice versa. The higher value of the angle of internal friction is pertinent for a container with a total active bottom and vertical walls or even with a container walls with negative angle.

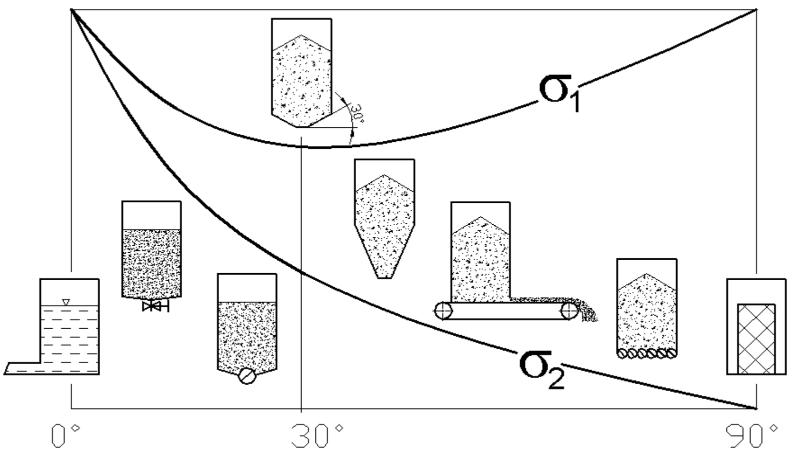

Fig.2 Logistics of container structure optimization with respect to $\sigma_1 \downarrow$, $\sigma_2 \rightarrow$ stresses as functions of the angle of internal friction $\varphi \varepsilon (0°,90°)$

2.3 Logistics of free stockpile with respect to bulk material type

The capacity and cost for building an opened stockpile dominantly depend on the angle of internal friction and behavior of $\sigma_1 \downarrow, \sigma_2 \rightarrow$ stresses. Materials in free heaps undergo some changes of the angle of internal friction because of weather activity or because of material segregation in the process of pouring material on the heap. This impact can be eliminated by temporary consolidation of the material and material loosening by some piling machine. The Figure 3 shows a relation of the angle of the material slope and the angle of internal friction of the bulk material.

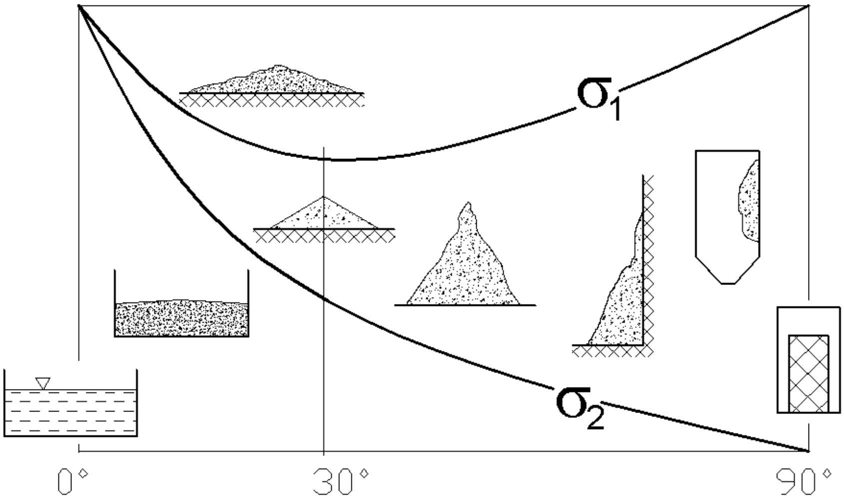

Fig.3 Logistics of heap creation related to angle of internal friction φ and behavior of $\sigma_1 \downarrow, \sigma_2 \rightarrow$ stresses

3. Conclusions

Two aspects of logistics of bulk material which help to improve ecological character of bulk materials operations by keeping their economy and functional stability of processes. (production, storage and transportation of bulk material).

The first method leading to a functional stability and economy of transportation route is to design measures ensuring that the angle of internal friction remains constant along the whole transportation route (multidimensional function expressing loss of work). This type of solution is technically and in collecting information quite demanding. For this reason watching an angle of internal friction at specific and mostly critical points of transportation route is sufficient. The task leads to a control of the angle of internal friction and to its stabilization within a relatively narrow interval of values.

The second way for achieving a functional stability and economy of a transportation route is to design geometry and dimensions of this route (inlet and outlet holes, falling heights, types of conveyers, angles of route direction changes and other items) in all cases respect momentary angle of internal friction corresponding to a concrete point of transportation route and to respected principle of flow continuity. This task leads to the optimization of a) geometry of transportation route and of b) velocity of bulk material. This solution for transport routes is more frequent than the first one.

A common practice however is that the designed transportation route is constructed with respect to some fictive and expected properties of bulk material and that the complex project is brought to operation by a method of consecutive approaches and additional alterations to come to an optimum functional condition. This procedure results from a certain lack of information and lack of knowledge of concrete mechanical and physical properties of bulk materials and their relation to the expected transportation route. A certain role plays an effort of a construction office to reduce the cost of the transportation route. After that the route is additionally altered, step by step, appended by necessary and mostly costly components, and brought to a demanded operation.

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