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APPLICATION OF ERGONOMIC PRINCIPLES ON THE DESIGN OF SPECIFIC TOOLS FOR THE OPENING AND CLOSING OF FLY VALVES.

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Summary

The need for specific and safe tools for particular work at industrial plants is steadily becoming more evident given the manifold processes developed in them.

This study presents the ergonomic principles followed in the design of two new tools aimed at the opening and closing of fly valves as a means of drive and control.

The result has been new, safer tools, which make the most of the worker's muscular effort, preventing injuries and damages to the installation.

Introduction

Among the most usual activities in industrial environments is the handling of control wheels, both for the adjustment of liquid and gas fluxes regulated by valves and for mechanical processes in opening and closing of gates.

This activity is usually hindered by the state of maintenance of the gears and threads on which the wheels move (presence of grease, dampness, corrosion, etc.), environments where permanence is time-limited (due to extreme temperatures, explosive or suffocating atmosphere, etc.) and forced postures which demand a great physical effort from the worker which might derive into severe osteomuscular injuries.

DESIGN AND DEVELOPMENT OF THE "ANTHROPOMETRIC TURNING TOOL"

The process of design has followed the guidelines established in a conventional ergonomic model (*Galer, 1987*):

STAGE 1: IDENTIFICATION OF THE PROBLEM

Though nowadays valve actioning is mostly carried out by means of pneumatic and electric equipment which make the worker's direct intervention unnecessary, manual handling is still quite usual.

Due to the overexertion and the use of tools hand-made with steel soldered and bent, with no constructive or structural control, which means a high risk of punching in case of fracture of the tool because of fatigue of the material, it is necessary to design a stable, sturdy tool which fits perfectly around the wheel and grants safe and comfortable handling.

Image 1 *Tool used in the opening and closing of fly valves.*

Image 2 *Tool bent due to fatigue.*

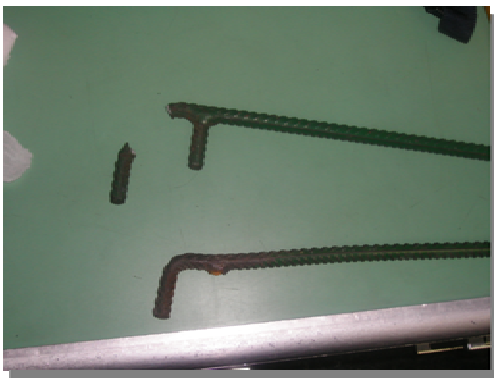

Image 3 *Tools broken due to overexertion*

STAGE 2: ANALYSIS OF USER'S NEEDS

Once the problem had been identified, workers helped identify the basic characteristics of a tool aimed at actioning wheel:

- Tool must be stable when used on wheel.
- Tool must be an appropriate size so as to ensure safe handling of a wide range of Wheel sizes.
- Lever arm must be long enough to make the most of the effort.
- It must not be too heavy, but have high mechanical resistance given the high machine effort it will have to endure.
- Handle must be comfortable and not slippery
- It must be designed for ambidextrous use.
- It should be easy to store, clean and upkeep.
- It should be clearly visible and easy to find in the installation.

A market search was carried out for manual tools which could offer an alternative, with no positive outcome.

STAGE 3: CONTRIBUTION OF DESIGN CRITERIA

• *Building material*

Various materials were assessed to ensure the strength of the tool, and finally it was decided to use steel EN-GJS-500-7, with a high resistance to traction, breakage, torsion and compression and whose specific density also prevents the tool from being too heavy.

• *Design Process*

Various design alternatives were analyzed and several prototypes elaborated before the definite model was agreed on. The result is a medium-sized tool, weighing about 2 Kg. and consisting in a handling head, made up of a cover and a hook on top fixed on the wheel spokes. Joined to the handling head by mechanical fixture, there is a 80 cm long tubular handle with double ergonomic grip. A surface galvanizing treatment is considered necessary to increase resistance to corrosion.

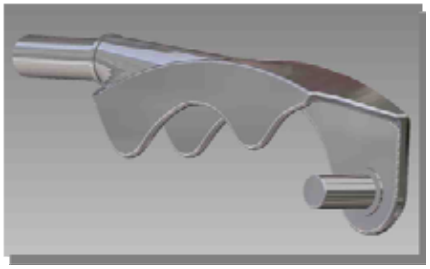

Image 4 *CAD of the design of the handling head.*

STAGE 4: FINAL EVALUATION OF THE PRODUCT

Various prototypes were tested by workers at the Thermal Power Plant in Aboño (HC Energía), resulting in the following feedback:

- **It achieves optimal stability when gripping the wheel while minimizing the worker's effort.**

The use of the tool is simple but very effective, as it is based on the levering principle. Once positioned, the tool does not move or slid over the wheel thanks to the side prolongations, so it does not damage to it and prevents it from slipping.

Image 5 Prototype tool in test

- **The length of its handle maximises power when carrying out task.**
- **The ergonomic handle ensures firm grip by enabling full hand use, which prevents dangerous slippings.**

For the design of the gripping area, anthropometric measurements have been taken into account as regards a good hand cover, of fingers and hands of percentile 95 of Spanish population published by the Ministry of Work and Social Affairs of the Spanish government, which makes it possible to use while wearing work gloves. Besides, its handle makes it impossible to use with tubes extending the lever arm.

- **Easy storage thanks to a hole in the handle which makes it possible to hang in the work area.**
- **Its metallised color and its coloured handle make it very visible in scarcely illuminated or dust-filled situations.**

Image 6 *Tools hanging on the support.*

- **It can be used on wheels in both horizontal and vertical position.**
- **Easy to clean thanks to its rounded shapes.**

Image 7 and 8 The tool allows the opening and closing of vertical and horizontal fly valves.

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DESIGN DEVELOPMENT OF "LLAVE ANTROPOMÉTRICA FIJA"

Following the guidelines of the design of the abovementioned tool, a new approach was taken based on the possibility of adding a lever in the piece of the fly valve.

STAGE 1: IDENTIFICATION OF THE PROBLEM

When the space between wheels was minimum or an Anthropometric turning tool was not available, a joint became necessary in the wheel to maximize the power of the lever applied. Said joint should be able to turn at the handle along with the movements of the wheel so that operators did not have to overexert themselves when turning it. This possibility was also convenient in those cases when there were few wheels which required effort in their use.

STAGE 2: ANALYSIS OF USER'S NEEDS

Once the problem had been pinpointed, the new needs that the tool should cover were analyzed:

- It must join the wheel perimeter, to make the most of the power.
- It should allow for placing in both positions (axial and radial).
- Its material and the system of screws must be resistant enough to withstand the force to be applied.
- The handle must be gyratory so it moves along with the movement of the auctioned.

STAGE 3: INCLUSION OF DESIGN CRITERIA

• *Material*

Due to the mechanical demands this new tool is to withstand, it was decided to use 2,5 mm thick steel. It is covered with galvanized paint to avoid possible corrosion.

• *Design process*

The design allows its joint on wheels of any diameter and ensures stability and hold thanks to its fit system by means of mechanized pieces and the use of screws.

The push axis contains an internal wharf which, on actioning, allows it to be placed in radial and axial position and the handle, with an ergonomic handle, allows a free turn.

Image 9 and 10 The

Anthropometric tool placed with the grip in axial position.

Image 11 and 12 The

Anthropometric tool placed with the grip in radial position.

STAGE 4: FINAL EVALUATION OF THE PRODUCT

After applying and trying out various joints on different-sized wheels under normal use conditions show that:

- **It is completely adaptable to wheels of any diametre and remains firmly joined thanks to its union by means of screws.**

It has been tried out on prototypes with different traction intensities and remained immobile and unaltered.

- **It makes manouvering much easier and prevents muscular fatigue derived from the action on the wheels.**

Conclusion

The steady improvement on working conditions must also include the correct design of the equipment and working tools in order to prevent muscular efforts which might cause painful injuries and prolonged sick leaves. On certain occasions, the lack of an appropriate tool means the tasks are carried out with hand-made tools whose handling involve intolerable risks.

These two tools and their original design allow for tasks to be carried out safely and preventing the overexertion and bad postures of workers associated to opening and closing.

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