Occupational Risk Assessment for Coil Slitting Set Up Operators

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ABSTRACT

Slitting is one of the metal cutting processes where large rolls, or coils, of sheet metal stock are cut by use of extremely sharp rotary blades. Slitting is performed on slitting lines that consist of four basic (the uncoiler, the slitter, a tensioning device, and the recoiler) operations. Several factors such as horizontal knife clearance, depth of penetration, size of the stripper rings, material characteristics, and the slitting head should be taken into consideration to obtain a quality slit. However, setting and maintaining the slitter safely is crucial not only for quality but also for workers’ health. Therefore, this study focus on slitter set up operators and Rapid Assessment of Entire Body (REBA) and Quick Exposure Check (QEC) analysis are performed with the occupational physician at the company. Installation and aligning knives, disk cutters or fixtures to the slitter are identified as the most problematic operations and potential occupational health and safety risks throughout the set up process are also defined. Investment that is suggested to improve set up operations and outcomes are discussed.

INTRODUCTION

Slitting set up process aims properly managing all variables such as horizontal knife clearance, depth of penetration, size of the stripper rings, material characteristics, and the slitting head properly under the pressure of meeting a production schedule. The setup needs to be extremely precise. On the other hand, work postures of set up workers should be assessed.

Several observational methods have been developed to assess the risk factors of work-related musculoskeletal disorders [1], [2]. The advantages of the easy to use musculoskeletal disorders are compared [3]. REBA and QEC are known to be the two general methods in this field. The significant correlation between two methods for identifying risky jobs, and determining the potential risk for incidence of MSDs are provided [4].

Up to best knowledge, this study is first to consider coil slitting set up workers. Aim of the study is to attract attention to these critical set up process by use of methods such as REBA and QEC. The occupational physician of the company who tracks the health

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records of the workers also have an impact to establish priorities for assessment, illustrate workplace postures, and score the assessment.

Second section provides the details of the process and explains how REBA and QEC methods are conducted. The results are discussed in the third section and conclusions are provided in the last section.

**METHOD**

**Basic Principles of REBA and QEC**

REBA has been developed for a practitioner's field tool, specifically designed to be sensitive to the type of unpredictable working postures found in health care and other service industries [5]. However, basic principles are also used to assess workers at manufacturing area. Main steps of the method is summarized along with a REBA assessment worksheet [6]. QEC is based on epidemiological evidence and investigations of OSH practitioners’ aptitudes for undertaking assessments [7].

The entire body can be evaluated by use of REBA and QEC methods. REBA can focus on posture of trunk, neck, legs (in combination with force/load score) upper arms, lower arms, and wrists (in combination with coupling score). On the other hand, the QEC take into account the posture of back, shoulder/upper arm, wrist/hand, and neck combined with the score of task duration, weight handled, hand force exertion, vibration exposure, and visual task demands.

**The Problem in Concern**

Slitter machines are commonly used in heavy industry, paper industry or a like. The typical one-dimensional slitting problem cannot be utilized because, the number of pieces that must be cut for each order may not be known [8]. It is usually costly to change the slitter settings coils of a given width and total weight are to be slit from an inventory of larger coils whose widths and weights may vary substantially. Pioneering studies in this field provide the use of a linear programming model to produce an optimum slitting schedule that minimizes trim and inventory costs subject to several common production and material constraints [9]. In practice, to achieve a quality slit, the length of product should be adjusted by using gauges and hand tools and cutting speed should be tested and adjusted [10].

The company in concern is the world’s leading producers in the steel pipe industry. It has 5 plants in 3 continents and 1.4 million tons of production capacity. Main operations in ERW pipe plant focus production of water, gas, oil, boiler pipes, construction pipes and profiles. The coils require slitting to the specified width for each product. Before starting the slitting operation, the worker have to select, clean, and install the related spacers, rubber sleeves, and cutter on arbors. The alignment of cutters are vital to avoid cut strips for flatness, holes, burrs, and surface defects in terms of quality. The responsibilities and tasks for slitter machine set-up operators can briefly be summarized as installing and aligning knives, disk cutters or fixtures to shear, bevel, or trim fabricated items. Due to the dependence on high workforce and skills, the set up process is also very critical in terms of occupational health and safety and requires attention.
The set up process and operations are quite similar and currently conducted by workers. However, the cutter installation is named based on the size of the cutter as small cutter and large cutter set up.

Figure 1.(a) illustrates the two rows of block and small cutters that are carried by use on a crane. Set up worker is responsible of placing and then aligning the cutter. As can be seen from Figure 1.(b), kneeling can be required during the alignment of small cutters at the lower row. However, since the blocks are not fixed, it is easier for the worker to place the small cutters compared to placing the large cutters (Figure 1.(c)).

The large cutter blocks are carried the slitting line by use of a crane. Large sized cutters, each around 50 kilograms, are ordered on the blocks by hand and blocks are formed of two rows. Cutters are carried to the area of bocks by use of a hoist and then handled by hand and adjusted through the block. Based on the operation, two operators either place or remove the cutters on the block together. Placing the large cutters takes around 3 or 4 hours. Current large slitting block technology is rather old and the headings are fixed. The mechanism allows moving the mandrels in a limited angle.

The setup apparatus for large cutters is represented in Figure 2.(a). The red circle points the fixed heading to the floor and the red arrow the floor where set up worker requires to step on during the cutter alignment.

Figure 2(b) represents the working posture of the worker during large cutter placement. The worker needs to bend to reach the lower block during placement and alignment. The worker is right handed and needs to push the cutter while holding the cutter from the bottom. His legs are unbalanced during the set-up procedure.
RESULTS

The posture of the workers who are involved in set-up operations are assessed by use of REBA and QEC methods. The posture of the worker during large cutter installation at the lower row is identified as more critical during the observations. Figure 3. represents how REBA score is calculated for the posture in concern. The final REBA score of 12 indicates high risk and calls for further investigation and engineering and/or work method changes to reduce or eliminate MSD risk for the large cutter placement.

Figure 3. REBA score for large cutter installation.

QEC method is also used to assess the large cutter installation and to get feedback from the worker. Table 1 summarizes the final score. Based on the suggested exposure score levels, it is clear that back has the highest risk. When shoulder and arm is assessed, Height & Weight (12), Height & Duration (6), Duration & Weight (10), Frequency & Weight (8), Frequency & Duration (2) the total score is calculated as 38 that falls the high risk level. This result is influenced by the manually handled very heavy cutter. It is obvious that the cutters are too heavy and body posture of the worker is not appropriate and requires an improvement. During the interview with the worker, he stated that he is constantly having whole body aches.

Table 1. QEC scores for large cutter installation.

| Exposure score | Low | Medium | High | Very high |
|----------------|-----|--------|------|-----------|
|                | 8-15| 16-22  | 29-32| 29-40     |
|                | 10-20| 21-30 | 31-40| 41-56     |
|                | 4-6 | 21-30  | 31-40| 41-56     |
|                | 1   | 8-10   | 12-14| 16-18     |
|                | 1   | 4      | 9    |           |
|                | 1   | 4      | 9    |           |
|                | 1   | 4      | 9    |           |
|                | 1   | 4      | 9    |           |
|                | 1   | 4      | 9    | 16        |

Table 1. QEC scores for large cutter installation.
DISCUSSION

The mandrels are fixed to the platform on the floor and since the headings cannot being separated, applicable solutions are limited. Set up workers need to step on the platform during alignment that leads to bad postures; especially when working on the cutters at bottom row. Figure 4.(a) provides the suggested lightweight spacers. Red arrow on the right hand side points the solid metal spacers. It is clear that lightweight spacers are designed to be easier than solid metal spacers to lift and handle during setup.

To improve the system, setup should be completed with the aid of a mechanical lifting device where the blocks can easily be replaced (Figure 4.(b)). New investments are expected to pay back in short time when costs of accidents and direct and/or indirect worker related health problems considered. The company is also supports new technologies and aware that workers’ health is critical to sustain operations.

CONCLUSIONS

It is usually stated that the problems that can arise during metal slitting include poor edge quality, edge burr, edge wave, camber, crossbow, knife marks, and slit width that is out of specification. In addition, some slitting problems can be attributed to poor metal quality. The common problems may be optimized with the proper variables and factors during the slitting process [10]. Each machine, metal type, and tooling set might follow different rules. Therefore, it is important to record the results of each slitting operation and continuously improve by monitoring the results. However, set-up workers and their occupational health are overlooked in many real life cases.

This study attracts attention to the importance of on-site and classroom training of musculoskeletal disorders, safe handling of slitters, slitter adjustment, alignment and setup, process and maintenance. Results and suggestions are expected to inspire other researchers and practitioners. As also stated in [11], results of REBA and QEC reveal a significant correlation between final scores and action levels. Conducting observational methods systematically may enable the decision makers to criticize the importance of occupational health risks and prioritizing the investments accordingly.

Similar studies can be conducted for paper and textile industries where slitting set-up operations are required. Further studies may also utilize methods like Cornell Musculoskeletal Disorder Questionnaire (CMDQ) to identify which part of the body has more pain and under more risk in terms of work related musculoskeletal disease.
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