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Analysis of hazards and risks in drawing machines

Análisis de peligros y riesgos en máquinas trefiladoras

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Abstract

This work aims to identify the degree of risks based on the dangers to which wire drawing machine operators are exposed. An evaluation is also carried out with the purpose of reducing accidents when workers operate this type of machine. The methodology used for this analysis is carried out using a tool called Operation, Risks Corrective Actions (ORCA). This type of tool is a format implemented by the company and compatible with most of the risks that may exist in each area that makes up the company. Carrying out this risk and hazard analysis will help control and prevent accidents, help implement and improve safety protocols, as well as improve learning to carry out efficient control in preventing accidents that could occur. present and identify the level of risk.

Danger, Risks, Wire drawing machine

Resumen

Este trabajo tiene como objetivo identificar el grado de los riesgos a partir de los peligros a los que se encuentran expuestos los operadores de las máquinas trefiladoras. También se realiza una evaluación con el propósito de reducir los accidentes al momento de operar este tipo de máquinas por los trabajadores. La metodología utilizada para este análisis se realiza mediante la utilización de una herramienta llamada Operation, Risks Corrective Actions (ORCA). Este tipo de herramienta es un formato implementado por la empresa y compatible con la mayoría de los riesgos que puedan existir en cada área que integra la empresa. Con la realización de este análisis de riesgos y peligros se contribuirá a controlar y prevenir accidentes, se ayudará a implementar y mejorar protocolos de seguridad, así como también mejorar el aprendizaje de para llevar a cabo un control eficiente en la prevención de accidentes que se pudieran presentar e identificar el nivel de riesgo.

Peligro, Riesgos, Trefiladora

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Introduction

Drawing is the process used for the reduction of a wire from a given diameter to a smaller one, (MARIO FRIGERIO S.p.a., 2007).

The wire is passed through a conical hole. And from the other side it is pulled with force causing a stretching of the material. This can be done continuously by using a drum which rotates constantly pulling wire and coiling it. This drum may be connected to another drawing die with an even smaller orifice. This, too, is pulled by another drawing drum, and so on constantly until the desired diameter is obtained, (Aceros Torices S.A. de C.V., 2023).

For the wire drawing process, some of the following operations are carried out in the machining process:

- Load the raw material through a spool.
- To arrange the wire by the pulleys in the wire drawing machine.
- Designate the diameter for the first dies of the wire drawing machine.
- Join the two ends of the wire with solder.
- Grind the soldering solder at the junction of the two wires.
- Attach the drag dog to the block at the other end of the wire rod tip until the block is 3/4 of its maximum capacity.
- Pass the wire onto the reel by passing its tip through the hole.
- Start the wire drawing machine.
- Exit of the reel and weighing.

During the wire drawing process, there are risks such as the following:

- Mechanical risks.
- Electrical risks.
- Thermal risks.
- Radioactive risks.
- Hygiene and safety risks.
- Ergonomic risks.

In this work, an analysis and study is carried out to determine the degree of risk involved in each of the processes carried out during wire drawing.

Risk Matrix

The risk matrix is a document that allows the identification of the activities carried out by a company, the risks inherent to them and the probability of these risks materialising. It is a tool for documenting processes and assessing the overall risk of an organisation, (Romero, S., 2022).

RISK MATRIX
JOB HAZARD ANALYSIS

Probabilidad	¿Puede Ocurrir?	¿Frecuente?	Ocurrencia Observada			Severidad				
						Seguridad Salud	No hay efectos adversos	Lesiones ligeras	Lesiones menores y días perdidos a uno o varios trabajadores	Largo tiempo de ausencia a uno o varios trabajadores	Fatalidad
						Medio Ambiente / Área Afectada Pérdida Económica / Remediación	Puntual < 1000 € < $16000 MXP	Planta < 10.000 € < $160000 MXP	Sitio < 100.000 € > $1600000 MXP	Área Industrial con Vecinos < 1.000.000 € < $16000000 MXP	Vecindad con Área Residencial > 1.000.000 € > $16000000 MXP
							Insignificante 1	Moderado 2	Serio 3	Critico 4	Muy Critico 5
	Seguro	Constantemente Diariamente	Observada con frecuencia	Muy Probable	5	51	52	53	54	55
	Muy Probable	Frecuente Semanalmente	Ha ocurrido a menudo	Probable	4	41	42	43	44	45
	Probable	Ocasionalmente Mensualmente	Ha ocurrido en nuestra área	Posible	3	31	32	33	34	35
	Poco probable	Pocas veces Anualmente	Ha ocurrido en otro lugar	Remoto	2	21	22	23	24	25
	Muy Poco probable	Muy pocas veces Dentro de algunos Años	Nunca se ha oído que ocurra	Poco Probable	1	11	12	13	14	15

Figure 1 Risk matrix

The above matrix considers the severity of the consequences of the causes for a hazardous situation, and the probability of the hazardous situation happening.

The risk class is formed by the number of the severity level (first digit) and the number of the probability level (second digit).

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Severity level

1. Insignificant	No adverse effects on worker safety or health. No impact on the environment. Economic loss due to damage < 1,000 € (< $16,000 MXP).
2. Moderate	Minor injuries to the worker. An injured person. Injuries that can be treated with First Aid. Contained spill of hazardous substances. Emergency response with no injuries. No impact on the population. Damage causing negligible inoperability of equipment. Spills or discharges of hazardous materials on site or minor damage to the environment on site or remediation costs < 10,000 € (< $160,000 MXP). Negligible material or energy consumption, Easily reversible impact.
3. Serious	Worker lost time due to injury or minor injuries to several workers. One disabling accident. Multiple injured Small spill not containing hazardous substances. Inoperability of equipment for 1 to 10 days. Off-site spill or discharge of hazardous materials in industrial area or moderate environmental damage or remediation costs < 100,000 € (< $1,600,000 MXP). The severity of the impact depends on the hazardousness of the pollutants, or the availability of natural resources.
4. Critic	Severe injuries. Long absence of one or more workers, serious injuries to several workers or external personnel. Disabling accident or hospitalisation Affection of the industrial area. Spillage of uncontained hazardous material Inoperability of equipment for more than 10 and less than 90 days. Permanent damage to a localised section of the process or construction. Off-site spill or discharge of hazardous materials in a mixed area or extensive damage to the environment or remediation costs < 1,000,000 € (< $16,000,000 MXP). Medium reversible impact
5. Highly critical	One or more fatalities. Community affected. Injuries or fatalities in the community. Equipment downtime greater than 90 days. Off-site spills or discharges of hazardous materials in a residential area or extensive environmental damage or remediation costs of > 1,000,000 € (> $16,000,000 MXP). Hardly reversible impact

Table 1 Risk class by severity

Probability level

1. Unlikely	Never heard of it happening. Occurs between 100 and 1000 years. Imaginable to happen over a period of several generations. Very rare. Within a few years. Very unlikely to occur. Coincidence or sequence virtually impossible, a "one in a million" chance.
2. Remote	Has occurred elsewhere. Occurs between 10 to 100 years. On average once during the operational lifetime of the plant. Rarely, from once per month to once per year. Unlikely to occur. Would be a remotely possible or very unusual coincidence.
3. Possible	Has happened in our area. Known to have happened. Occurs between 1 to 10 years. Likely to occur several times during the operational lifetime of the plant. Occasional, once a week to once a month. Likely to occur. It would be a rare or unusual but possible sequence or coincidence..
4. Likely	Occurred often, once a day. Occurs within one year. Likely to reoccur within 3-5 years. Likely to occur frequently during the operational life of the plant. Frequent. Weekly Very likely to occur. Very likely, not uncommon to have a 50/50 chance.
5. very likely	Frequently observed occurrence. Occurs more than once a year. Likely to occur within the next year. Constantly, or several times a day. It is certain to occur. It is the most likely and expected outcome if the event occurs.

Table 2 Risk class by probability

The Steps of a JSA (Job Safety Analysis)

1. Selecting the job to analyse

An effective JSA programme chooses and prioritises the jobs to be analysed. Categorise each job according to as many hazards as possible. The most hazardous jobs are analysed first. The following factors need to be considered:

- The frequency of accidents.
- The severity of the accident.
- New jobs, non-routine jobs or changes of duties.

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- Repeated exposure.

Note: remember that experienced workers can help identify potential hazards associated with a job.

2. Break the job down into basic steps

The analysis should not be so detailed that it results in a large number of steps, nor so generalised that basic steps are omitted.

Preferably an experienced worker should help divide the work into steps. The purpose and practicalities of a JSA should be explained to the workers, and once broken down, the list should be reviewed and approved by everyone involved.

Note: if there are more than 15 steps, the work should be divided into more than one JSA.

3. Identify the hazards within each step

Each step is analysed for existing and potential hazards, the hazard should be noted.

Consider these notations when evaluating each step of the job:

- Struck against.
- Struck by.
- Contact with.
- Being touched by.
- Caught in.
- Caught in.
- Caught between.
- Falling from the same level.
- Fall from another level.
- Overexertion.
- Exposure.

4. Control each hazard

In this step the control measures for each hazard are identified and noted, the control measure recommends a work procedure to eliminate or reduce accidents or potential hazards.

Consider these five points for each hazard identified:

- Change the work procedure.
- Change physical conditions.
- Change work procedures.
- Reduce frequency.
- Use personal protective equipment.

5. Review the Job Safety Analysis

The JSA is effective only if it is re-examined periodically or after an accident occurs to determine if new work procedures or protective measures are needed, (Texas Department of Insurance. Government Agency, 2023).

Considering the risk matrix and the steps to develop a job hazard analysis, a risk analysis was performed for a wire drawing machine called MT-106, where the following figure 2 shows the observed operation, the type of hazard it represents, the risk that could occur, the severity score and probability of occurrence, the type of evaluation and the action to be taken to mitigate or eliminate the risk.

Secuencia de operación	Peligros potenciales (SHEQ)				Acción correctiva
Operación	*Peligros*	*¿Qué pude suceder?*	*Riesgo*	*Evaluación*	*¿Cómo se puede evitar o eliminar?*
Carga de materia prima por medio de un carrete		El alambre que se utiliza como materia prima viene embobinado en un carrete y se coloca en una base especial para evitar que se mueva a la hora de girar y pasarlo a la trefiladora.	42	Probable	Se debe de usar el montacargas con precaución para poner el carrete en la base y se debe de evitar el contacto con el carrete si no se usan herramientas de trabajo.
Acomodo del alambre por las poleas de la trefiladora		En este proceso el operador puede sufrir de un piquete con el alambre o de un machucón con los dados.	42	Probable	El operador debe de utilizar guantes al momento de pasar el alambre por las poleas para evitar machucones y también cuando se colocan los dados, para evitar
Designación del diámetro para los primeros dados de la trefiladora		Se le hace un desbaste a la punta del alambre para que pueda entrar en los dados y se pueda unir con el alambre restante de carrete anterior.	32	Insignificante	El esmeril con el que se hace el desbaste tiene que tener guarda y el operador debe de usar guantes.
Unir las dos puntas del alambre con soldadura		El operador puede sufrir de alguna quemadura al estar soldando.	42	Probable	Se debe de usar equipo de protección adicional como lo es la careta de soldador y guantes que sean resistentes al calor.

El operador esmerila la soldadura que puedo en la unión de los dos alambres.		En esta parte el operador puede sufrir de quemaduras por parte de las chispas que crea el alambre y si no se tiene cuidado se podría raspar o cortar con la esmeriladora.	43	Importante	Se debe de usar el equipo de protección adecuado para este proceso como lo es una careta y guantes de soldador.
Fijar el perro de arrastre al block en el otro extremo de la punta del alambrón hasta llenar 3/4 su capacidad máxima del block		Al realizar todo este proceso pueden suceder accidentes, al colocar el alambre en los pasos a pueden haber machucones, se puede romper el alambre y herir al personal, se pueden picar con los amarradores de alambre y lesionar si los pasos se activan automáticamente.	43	Importante	La medida de seguridad principal es usar el equipo de protección personal completo y de la manera adecuada. Se recomienda que se usen las herramientas especiales para el manejo del alambre y no herramientas que los mismos operadores puedan crear y les sean funcionales.
Pasar el alambre al carrete pasando su punta por el barreno		Una vez que se colocó el alambre en las poleas es muy importante tener el control absoluto del alambrón porque este podría generar cortaduras o picaduras al momento de manipular el material.	42	Probable	Es importe que se utilicen guantes, casco y careta para evitar los riesgos.
Poner en marcha la máquina		Al dejar trabajando las trefiladoras con las guardas abajo, los operadores se exponen a que el alambre se rompa y le pegue a alguno de ellos, además que se pueden machucar si ponen la mano en alguno de los pasos de la trefiladora.	43	Importante	Es obligatorio que las trefiladoras trabajen con las guardas abajo y que las puertas donde está el carrete del producto final este completamente cerrada.
Salida del carrete y pesaje		Cuando sale el carrete de la máquina puede rodar y golpear a un operador, al pesarlo este también se puede balancear y golpear a un operador.	32	Insignificante	El operador debe de verificar que el carrete salga con poca fuerza de la máquina y que a la hora de levantarlo con el polipasto sea en una dirección recta para evitar que se pueda balancear.

Figure 2 Risk analysis for MT-106 wire drawing machine

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Conclusions

As a result of the risk analysis carried out, shortcomings were identified in the personal protective equipment, as well as in the tools used by the operators to handle this type of machine.

Various hazards or risks that were present in the plant were identified and measures were taken to minimise them.

The following figure shows the reduction of accidents caused by the risks detected:

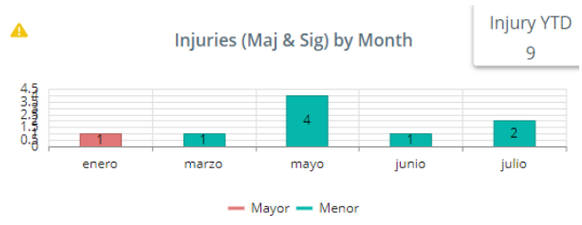

Figure 3 Accident reporting from January to July

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