Journal of Data Acquisition and Processing
ISSN: 1004-9037
https://sjcjycl.cn/
DOI: 10.5281/zenodo.776925

REDUCING WASTE AND DISCARD IN DIRECT EXTRUSION PROCESS BY SELECTING SUITABLE BILLET SIZE IN HOT EXTRUSION PROCESS

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Abstract:

This article discusses the various operations and cause of defects involved in the hot extrusion process, such as the furnace, hot log machine, billet preheating, extrusion press machine, stretching machine, pulling machine, conveyer rollers, cutting machine, and so on. In the extrusion process, hefty tooling and equipment are used. It is vital to understand the relationship between the extrusion press condition, equipment, and their performance measured in terms of productivity and recovery of cost. To understand the defects that contribute to and control the factors that affect the extrusion profile and occur the waste in the forward extrusion process, The quality of the extruded profile is the key function of various factors such as geometric dimension, appearance of profile, variation of mechanical properties over the extruded profile length, shape, cross section, and surface finish. Most extrusion profile defects may arise because of billet material and billet size selection by manpower. In the article to describe to reduce the waste and discard in forward extrusion process.

Introduction:

Forward(hot) extrusion process is primarily a hot working process with high productivity and low rejection rates.Six functional groups can be readily identified in the layout: material selection, material preparation (billet preheating and sizing for various cut length, die and die set preheating), extrusion process, product size and shape correction (stretching/straightening, roll correction, saw cutting to final size), aging. From a defect’s viewpoint, the hot extruded profile may either be reworked or rejected. Rejected aluminum profiles is undesirable because it leads to material and manpower/ processing loss, in addition to the extra cost required to make up for the rejected profiles. This rejection occurs due to defective billets, faulty or unsuitable tooling, processing anomalies, post extrusion defects, and surface finishing defects. For ease of quality assurance and costing activities, the entire setup has been divided into three major cost centers: press (all activities up to and including age-hardening furnaces), anodizing, and painting.XYZ Company makes various types of aluminum profiles with different sizes of cut length. Many different types of defects affect aluminum profiles, including physical defects, mechanical defects, and manpower defects. And that directly affected the cost of the product.

So, after selecting this project, started collecting waste-related data using quality control tools (pareto chart, Ishikawa diagram, why-why analysis). Some major factors that directly affected the cost are, selection of billet and material of billet, selection of billet length, waste from discard (the last part of log).

Table 1 waste from various defects for last 6 months.

Defects	Waste in kgs
Dents	28991 kgs
Bend and twist	14183 kgs
Scratches	5739 kgs
Pick up by rollers	4492 kgs
Blister	3750 kgs
Damage	3612 kgs
Porosity	2162 kgs
Total	62,929 kgs

DISCRIPTION OF VARIOUS TYPES OF WASTE:

In the hot extrusion process the waste from aluminum product of extruded profiles are divided into two categories:

1- Physical scrap
2- Technical scrap

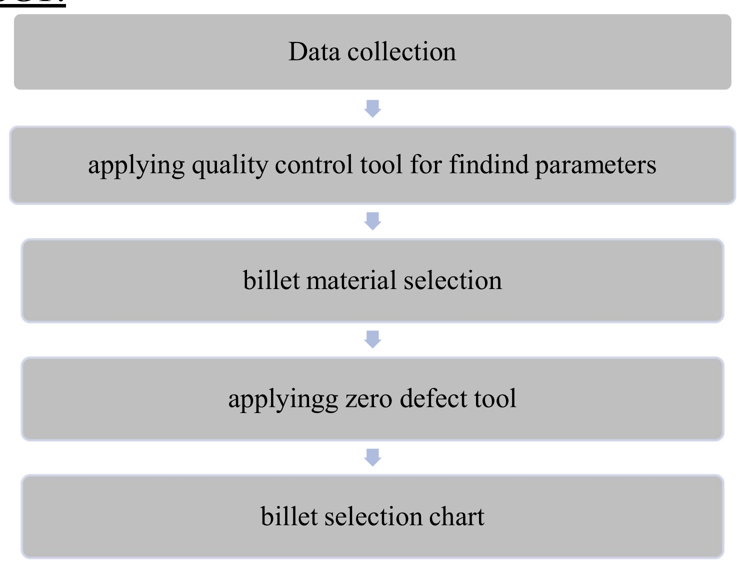
Physical scrap: physical scrap is an unavoidablewaste, whichoccurs in the aluminum extrusion process, like while cutting the profile, by puller speeds, the unwanted parts on the roller surface, etc. Both ends of the product can be called as a waste part of that particular profile in the starching machine during stretching. the material discarded because the length of the fixed-length material is not enough; necessary cutting samples; aluminum stuck in porthole dies after the production; and, as they are also called, waste parts; aluminum chips scrapped in billets. If the faulty billet was running in the press, the die would open and the die would be damaged at that time. Technical scrap as the following:
Unqualified mechanical properties - the strength and hardness too low and do not meet the national standards or the plasticity is too low not fully soften and does not meet the technical requirement

Surface scrape – layering, bubbles, extrusion cracks, orange peel, structural line, black spots, longitudinal weld lines, horizontal weld lines, scratches etc.

Physical dimensional scrap – waves, twists, bends, flat clearance etc.

Technical scrap is scrap generated during the production process of aluminum profiles due to unreasonable technology, equipment problems, and improper operation by workers. It is different from physical scrap in that technical improvement and management strengthening can effectively overcome and eliminate the occurrence of technical scrap.

METHODOLOGY:

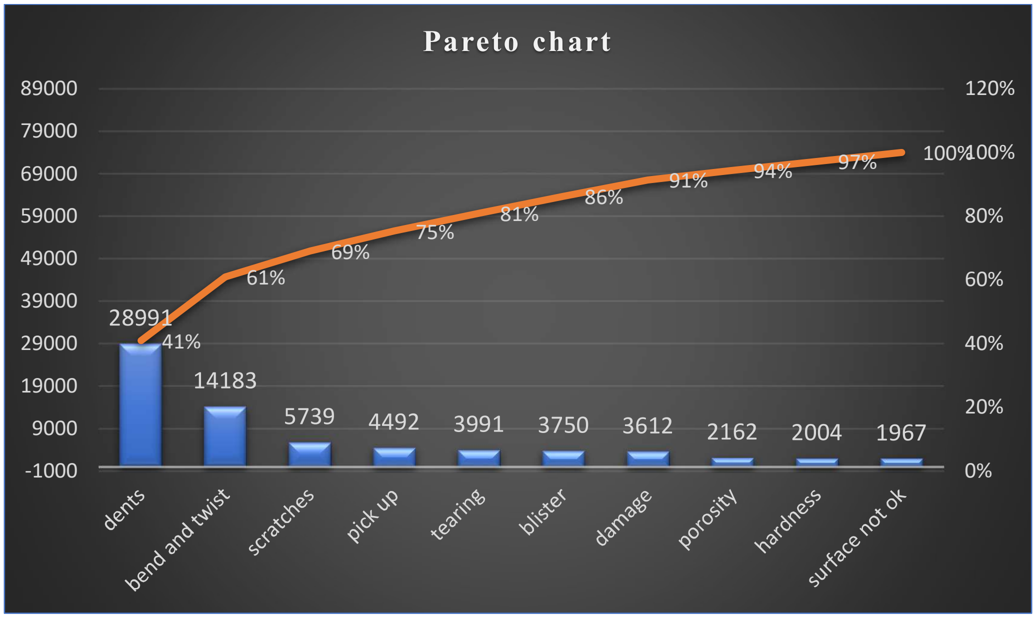


Empirical study for finding the parameters who 0ccure the waste.

Empirical study is based on observation and measured phenomena and derives knowledge from actual experience rather than from theory or belief. Empirical data can be collected through primary sources, surveys, observation, documentation, and experimentation. Empirical data is classified into quantities, qualitative, or a combination of both. Empirical evidence refers to factual data. Most factual data are represented in terms of numerical figures that can be verified and validated. Raw data is collected by conducting experimental and observations performed in a controlled environment.

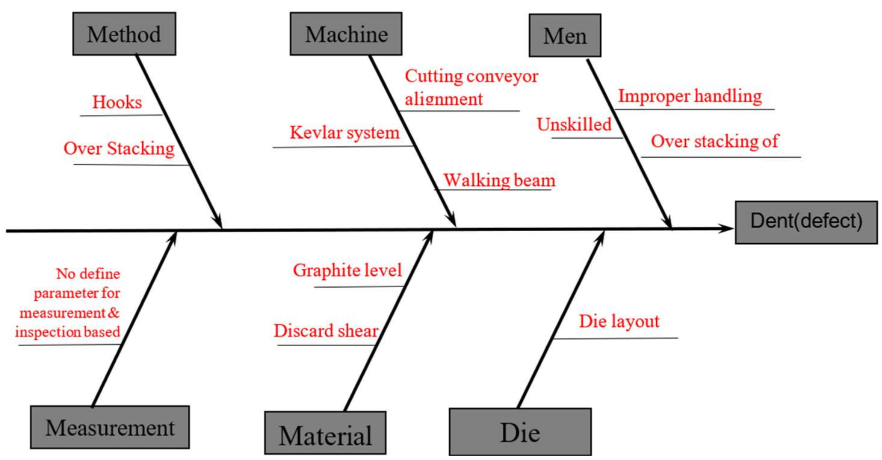
Pareto chart

Based on the information extracted from the rejection data of the last six months according to Table 1, the Pareto chart finds the most waste in the company is due to dent defects. Dent leads to 41% of production during production.41% of the profiles affected the production of plants. There are many causes of dent generation: gusseting, roller speed, stretching.



Ishikawa diagram:

The cause-and-effect diagram or Ishikawa diagram of dents shown below depicts the different means of causes, such as hooks of the crane. Overstocking in the racks comes under method. Like this, other issues or problems are categorized into machine, man, measurement, material, and die. These root causes provide us with additional insight into process behavior. To determine the cause of a problem, why-why analysis is preferable, as it appears in a research paper.



Example of why-why analysis for dent defects

Over stacking/material stacking in racks. The cause is **"Over stacking of profiles resulting in excess load on the bottom profiles, resulting in dents"**. Further, why-why helps to find problem as per our industries finds that the billet relation is affecting the billet. If billet size is not selected as per standards also can reduce productivity.

Why 1: Over stacking of profiles resulting in dents.

Why 2: Due to placing of heavy section upon the light section Also due to wrong stacking pattern

Why 3: There is no standard instruction for stacking profiles rack wise. Also, unskilled labors stacking material.

Why 4: Because of different types of shapes being extruded daily. Daily altering workforce.

For making billet size chart first to find 1mm billet weight:

∴ If log size is 17'x 5'' then,
- L= 17' =51816cm
- D=5'' = 12.7cm

∴ Area = $\pi x r^2$
= 3.24 x $(6.35)^2$
= 126.61 cm

∴ Aluminum density = 2.79 g/cm²
= 2710 kg/m³

∴ Weight = Area x length x density x 1/1000
= 126.61 x 518.61 x 2.7 x 1/1000
= 177.13 kg (1 log weight)

∴ Now Weight (1 cm billet) = 177.13/518.16
= 0.341 cm

∴ 1 mm billet = 0.0341 mm

No	Die Weight	Cut length	Billet Size	Piece
1	1	12'	190mm	6
2	1	13'	205mm	6
3	1	14'	185mm	5
4	1	15'	200mm	5
5	1	16'	210mm	5
6	1.5	12'	285mm	6
7	1.5	13'	310mm	6
8	1.5	14'	285mm	5
9	1.5	15'	280mm	5
10	1.5	16'	315mm	5
11	2	12'	380mm	6
12	2	13'	410mm	6
13	2	14'	370mm	5
14	2	15'	395mm	5
15	2	16'	420mm	5
16	2.5	12'	475mm	6
17	2.5	13'	510mm	6
18	2.5	14'	460mm	5
19	2.5	15'	490mm	5
20	2.5	16'	525mm	5

21	3	12'	570mm	6
22	3	13'	510mm	5
23	3	14'	555mm	5
24	3	15'	590mm	5
25	3	16'	505mm	4
26	3.5	12'	550mm	5
27	3.5	13'	605mm	5
28	3.5	14'	525mm	4
29	3.5	15'	560mm	4
30	3.5	16'	595mm	4
31	4	12'	520mm	4
32	4	13'	560mm	4
33	4	14'	465mm	3
34	4	15'	495mm	3
35	4	16'	365mm	2
36	4.5	12'	585mm	4
37	4.5	13'	490mm	3
38	4.5	14'	520mm	3
39	4.5	15'	555mm	3
40	4.5	16'	410mm	2
41	5	12'	505mm	3
42	5	13'	545mm	3
43	5	14'	580mm	3
44	5	15'	430mm	2
45	5	16'	455mm	2

Experiment outcome:

→ Weight = 4.700 kg (Die weight)

→ Length= 1860mm (Required length)

∴ 4.700 ÷ 12 x (47+1) ÷ 0.034 = 550mm (1 billet)

∴ here 48 = (47 + 1) (47 - cut length, 1 - waste)

Experiment waste:

Production team generated 20% (63 pcs)

Our team generated 7% (56 pcs)

Total aluminum save = 6 kg

Conclusion:

Aluminum extrusion waste generation is mostly related to the selection of billet size, conforming to the data found from the above experiment. The waste profile associated with aluminum extraction is more closely connected to physical waste than technical waste. With this improvement, the company will be able to reuse the waste portion. To maintain physical waste, it is needed to take care of cut length, according to billet, with this discard can also be used for running the die. Reusing faulty extrusion products results in a 30% loss in productivity since only 70% of the aluminum may be utilized, and the remaining 30% is made up of ash and dross. Excess discard (the last part of the log) is used to combine those parts from different logs into one billet in the extrusion process. As a result, these parts are saved to recycle and increase productivity. If the parameters (tooling operation, ram speed, temperature, die geometry, weld joints) are kept under control, the company can improve the production rate in less time with no re-work and with higher productivity.

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