

Final Exam MA 53– Spring 2024

Please answer on separated sheets of paper for each part

Part I: Hanlin LIAO / Lectures notes allowed but internet connection not allowed

Casting part:

1. Describe the process of investment casting and list the advantage and drawbacks of this process. Give an example (workpiece) of this process.
2. In sand casting process explain the function of following parts in the mould:
 - 1) pouring cup
 - 2) Core
 - 3) Vent
 - 4) Riser
 - 5) Cavity
3. Which one has higher shrinkage rate between these two materials: steel and grey cast iron? Explain your answer
4. Sand mould making is a heavy job with a quite dirty environment, can you propose some thing to improve this process?
5. Tesla electricity car uses a casted car body for several models. Describe the material and the casting technique that they used, explain the advantages and disadvantages.

Corrosion part:

1 To protect a steel structure, metallic coating is a sure way. If you have the methods to elaborate a coating on the steel, among different materials in following list, which materials do you choose? explain your choice. (suppose this coating can be probably damaged by mechanical way).

metal	Electrochemical potential (V)
Fe	-0,4
Cu	0,07
Ni	-0,02
Zn	-0,81
Al	-0,48

(solution NaCl 3%)

2. In 316L stainless steel, L stands for "low carbon". This steel has a better anti-intergranular corrosion property than that of 316. Explain the reason.

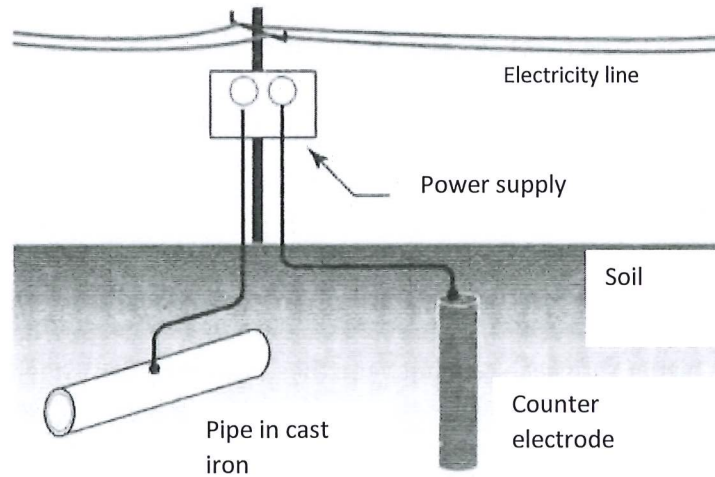
Composition of stainless steel 316 et 316L

Acier	C	Ni	Cr	Mo	Mn
316	0,05	16 à 18	10 à 12,5	2 à 2,5	2
316 L	0,02	16 à 18	10,5 à 13	2 à 2,5	2

3. In the case of cathodic protection, an electrical voltage is often imposed on the part to be protected when it is buried in the soil as shown in the figure on the left.

1) Indicate the polarity of the electrical power supply if the pipe must be protected in the ground which is a little acidic (PH=5) and also estimate the minimum voltage value imposed (consult the Pourbaix diagram of Fe for exercise 4) , argue your choice.

2) What is the best material for making the counter electrode?



4. In casting process of a copper piece, we put a Fe core in the mold, after casting, this core is still in the pieces of copper, we should remove it for forming a cavity in the piece. Right now, we should use an electro-chemical method to dissolve the Fe core. Observe the diagrams of copper and iron below,

1). Draw a schema to explain how connect the casted copper piece to aa electrical power-supply

2). Choose suitable parameters (voltage and PH value of chemical solution) to remove Fe and keep the copper without any corrosion.

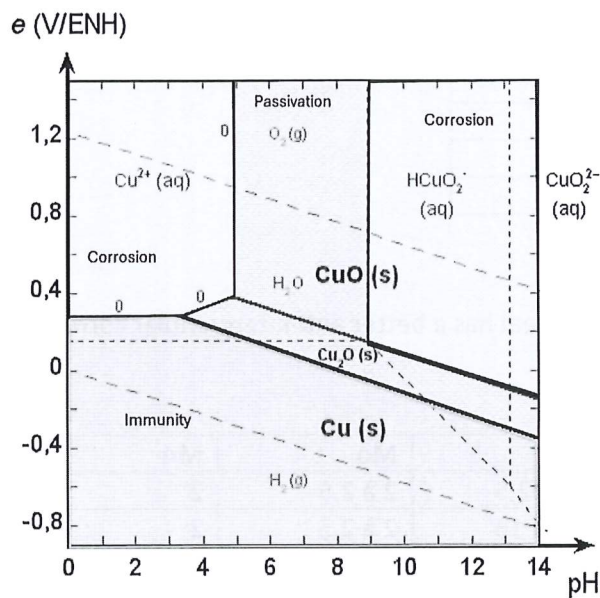


Diagram of E-PH of Copper

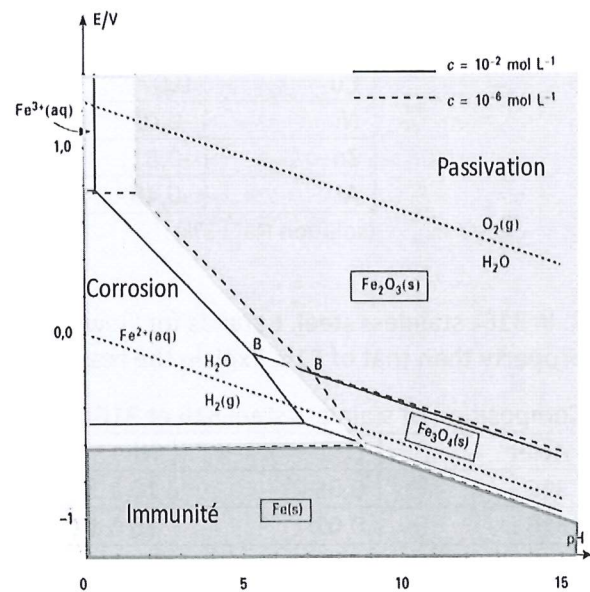


Diagramme potentiel-pH du fer (avec les oxydes)

PART 2

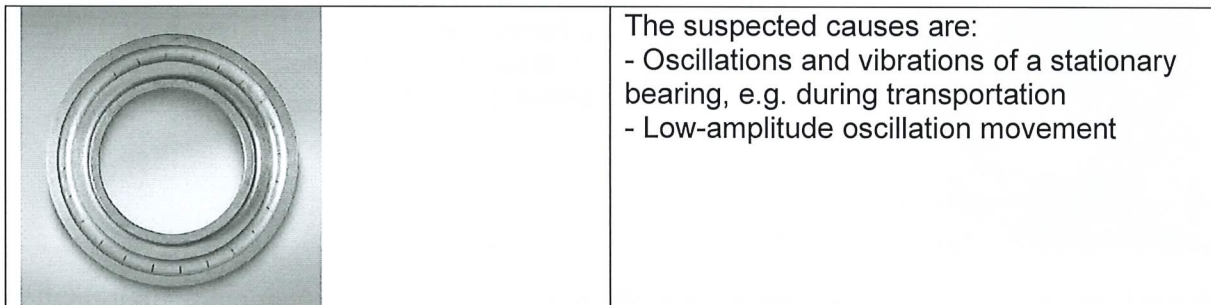
Topic : Friction**Exercise 1: Study of polishing**

We want to polish a part without removing too much material. First, we work on the polishing phases using SiC paper.

- 1- What type of wear does this process involve?
- 2- Why is a water flow used during polishing and what happens if the water supply is cut off?
- 3- Why is it recommended to change the paper very regularly?
- 4- What happens if the hardness of the sample is increased, and how can this modify the type of wear observed?
- 5- What type of wear is caused by switching to diamond suspension polishing?
- 6- Abrasive polishing is not recommended when you want to observe polished surfaces in detail. What changes (microstructure, properties, etc.) can this deliberate wear change on the surface of the material?

Exercise 2 "False Brinelling effect"

From the SNR website: "Among the various types of contact wear, false brinelling refers to the appearance of hollow marks that resemble "Brinell" marks and are due to wear caused by vibrations and oscillations at the points of contact between the balls and the raceway."



Based on your analysis of the mechanical ball/track contact, suggest a scenario for the formation of these regular, worn indentations

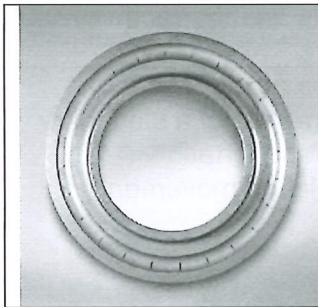
Exercice 1 : Etude du polissage

On souhaite réaliser un polissage d'une pièce sans ôter trop de matière durant chaque étape. On travaille tout d'abord sur les phases de polissage au papier SiC.

- 1- A quel type d'usure s'apparente ce processus ?
- 2- Pourquoi utilise-t-on un écoulement d'eau durant le polissage et que peut-il se passer si on coupe l'alimentation en eau ?
- 3- Pourquoi recommande-t-on de changer les papiers très régulièrement ?
- 4- Que se passe-t-il si on augmente la dureté de l'échantillon, comment cela pourrait-il modifier le type d'usure observé ?
- 5- Quel type d'usure provoque-t-on lorsqu'on passe sur du polissage avec suspension diamant ?
- 6- Le polissage « abrasif » n'est pas conseillé lorsqu'on veut finement observer les surfaces polies. Quelles modifications (microstructure, propriétés...) cette usure volontaire peut-elle engendrer en surface du matériau ?

Exercice 2 : Etude du Faux effet Brinell

Extrait du site SNR : « Parmi les différents types d'usure de contact, le faux brinelling désigne l'apparition de traces creuses qui ressemblent à des marques « Brinell » et qui sont dues à l'usure causée par les vibrations et les oscillations au niveau des points de contact entre les billes et la piste. »



Les causes annoncées sont:

- Oscillations et vibrations d'un roulement à l'arrêt, par exemple lors du transport
- Mouvement d'oscillation de faible amplitude

A partir de l'analyse du contact mécanique bille/piste, proposez un scénario pour la formation de ces empreintes usées bien régulières