



Platinum group metals and base metals refining: A summary of skin barrier function studies

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Introduction

- The skin, primarily the stratum corneum (SC), acts as a physical barrier preventing loss of body fluids and penetration of exogenous substances.¹⁻³
- Skin barrier function can be assessed through measurement of Transepidermal Water Loss (TEWL):
 - endogenous water loss through the SC
 - low TEWL representative of an intact skin barrier.²
- Other biophysical parameters supporting skin barrier function assessment:⁴⁻⁶
 - SC hydration
 - skin surface pH.
- SC hydration indicates the water content in the SC.²
 - Low levels indicative of skin dryness.

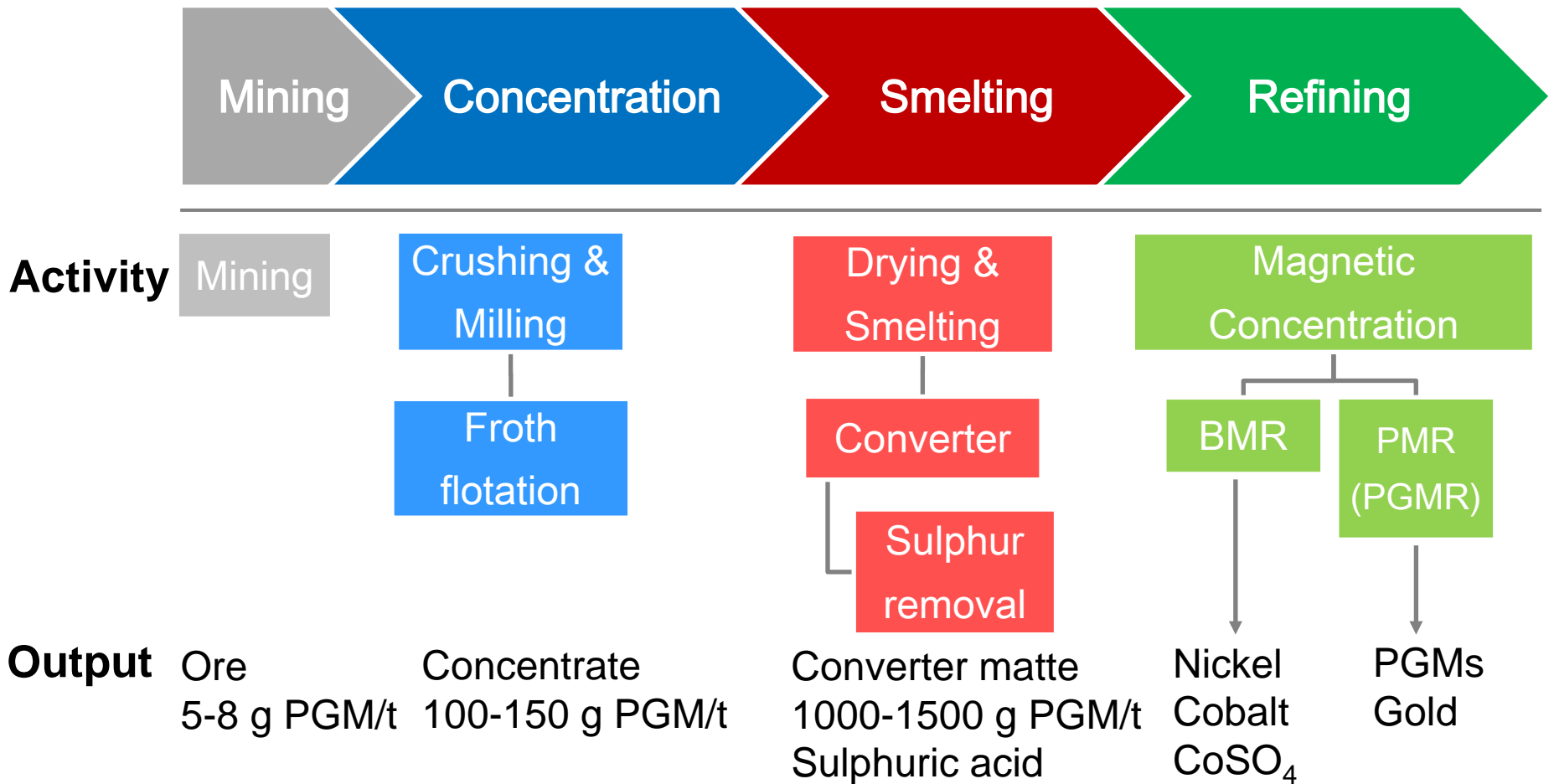
Introduction

- Skin surface pH (pH = 4.5 to 5.6), and the maintenance thereof important in:
 - SC integrity and cohesion
 - regulation of epidermal barrier homeostasis
 - maintenance of microbial flora balance. ⁷⁻¹¹
- Several studies were conducted in Platinum Group Metals (PGMR*) and Base Metals Refineries (BMR) in South Africa wherein skin barrier function of refinery workers were assessed.
- Primarily motivated by:
 - presence of numerous irritant and sensitiser chemicals
 - physical/mechanical skin damage (abrasions and cuts).

* Also referred to as Precious Metals Refineries (PMR)

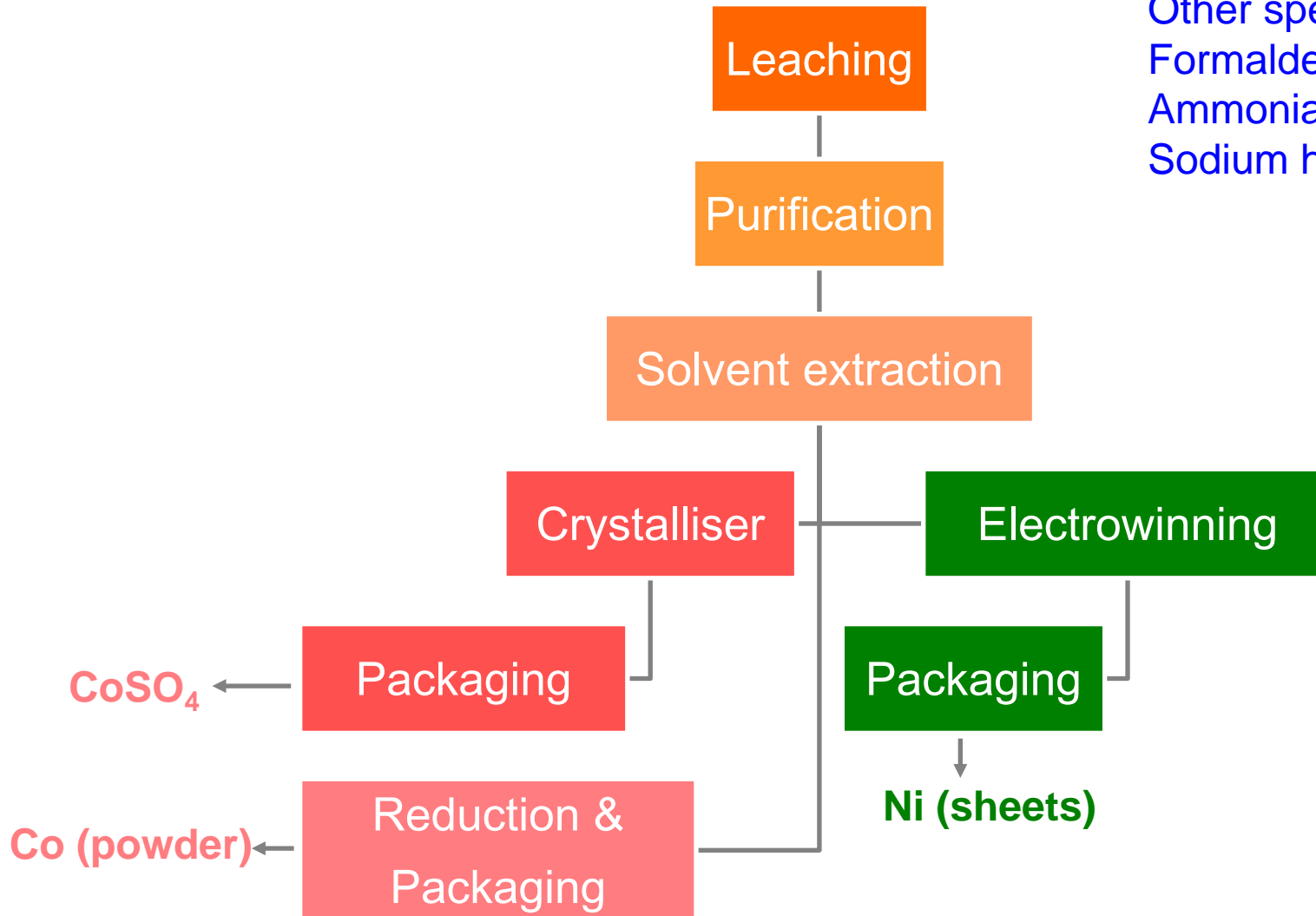
Introduction

PGM and BM recovery (simplified):¹²

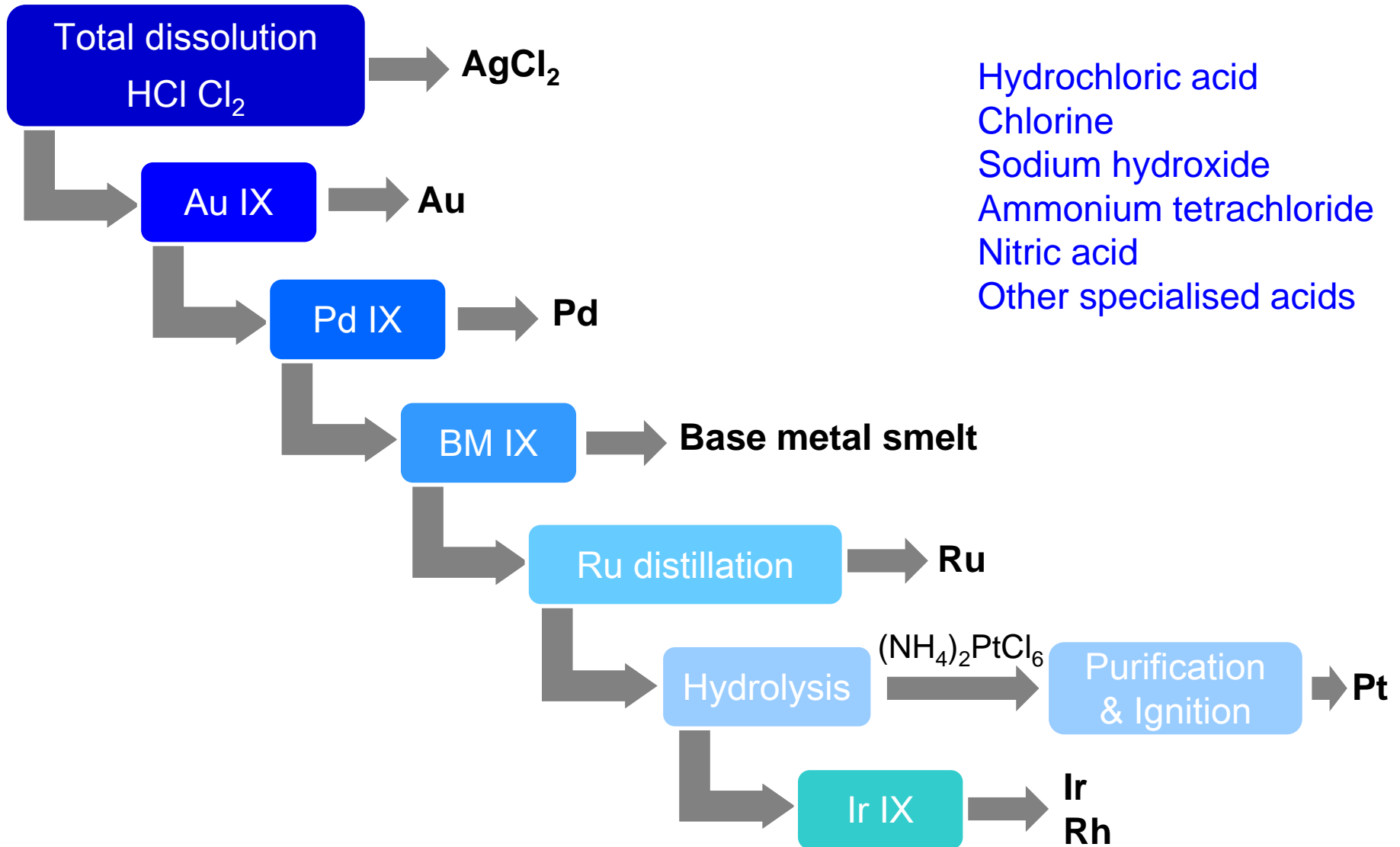


Introduction: BM recovery (simplified)

Sulphuric acid
Other specialised acids
Formaldehyde
Ammonia
Sodium hydroxide



Introduction: PGM recovery (simplified)



Methodology

- Skin barrier function assessed:
 - prior to and after a work shift (8 hours)
 - on different anatomical positions
 - expressed as $\% \Delta$ in the parameter during the work shift. ^{13,14}
- TEWL measurements:
 - EDS12 system (EnviroDerm Services) – initial 4 studies
 - Vapometer SWL4 (Delfin)
 - Tewameter TM300 with semi-enclosed chamber (C&K Electronic)
- SC hydration measurements
 - EDS12 (EnviroDerm Services) – initial 4 studies
 - Corneometer CM825 (C&K Electronic)
- Skin surface pH measurements
 - Skin PH905 pH meter (C&K Electronic)

Results: %Δ TEWL

| Study | Process | n | Anatomical positions | | | | | |
|--------------------------|--------------|-----------------|----------------------|--------------|--------------|-------|---------|-----------|
| | | | Index finger | Palm of hand | Back of hand | Wrist | Forearm | Fore head |
| 1. BMR A ^a 15 | Ni refining | 26 | | | | | | |
| 2. BMR B ^a 16 | Co refining | 13 | | | | | | |
| 3. BMR A ^b | Co refining | 12 | | | | | | |
| 4. BMR A ^a | Ni packaging | 24 | | | | | | |
| 5. BMR A ^a | Co packaging | 4 [#] | | | | | | |
| 6. PMR A ^c | PGM refining | 19 [#] | | | | | | |

^a EDS12, ^b Vapometer, ^c Tewameter, [#] repeated measure

| |
|--------------|
| > +15% |
| > +5 to +15% |
| -5 to +5% |
| > -5 to -15% |
| > -15% |

Results: %Δ SC hydration

| Study | Process | n | Anatomical positions | | | | | |
|--------------------------|--------------|-----------------|----------------------|--------------|--------------|--------|---------|-------------|
| | | | Index finger | Palm of hand | Back of hand | Wrist | Forearm | Fore head |
| 1. BMR A ^a 15 | Ni refining | 26 | Light Green | Yellow | White | White | White | Green |
| 2. BMR B ^a 16 | Co refining | 13 | White | Green | Red | Yellow | White | Orange |
| 3. BMR A ^b | Co refining | 12 | White | Orange | Orange | Red | Red | White |
| 4. BMR A ^a | Ni packaging | 24 | Light Green | Green | White | White | Green | Light Green |
| 5. BMR A ^a | Co packaging | 4 [#] | White | Green | Light Green | Green | White | Yellow |
| 6. PMR A ^b | PGM refining | 19 [#] | White | Red | Orange | Orange | Yellow | Yellow |

^a EDS12, ^b Corneometer, [#] repeated measure

| |
|--------------|
| > +15% |
| > +5 to +15% |
| -5 to +5% |
| > -5 to -15% |
| > -15% |

Results: %Δ Skin surface pH

| Study | Process | n | Anatomical positions | | | | | | |
|----------|---------------------------|-----------------|----------------------|--------------|-------|---------|-------|-----------|------|
| | | | Palm of hand | Back of hand | Wrist | Forearm | Cheek | Fore head | Neck |
| 2. BMR B | Co refining ¹⁶ | 13 | | | | | | | |
| 4. BMR A | Ni packaging | 24 | | | | | | | |
| 6. PMR A | PGM refining | 19 [#] | | | | | | | |
| 7. PMR A | PGM refining | 14 [#] | | | | | | | |

repeated measure

| |
|--------------|
| > +15% |
| > +5 to +15% |
| -5 to +5% |
| > -5 to -15% |
| > -15% |

Skin surface pH

- Further interest in the decrease in skin surface pH and its relationship with the “acidic” nature of refining processes.
- Is airborne HCl in certain areas of the PMR responsible for the decrease in skin surface pH?
 - Area HCl exposure = 2.12 ± 3.61 ppm
 - Personal TWA_8 HCl exposure = 0.63 ± 2.72 ppm
 - No significant correlations between personal exposure and the skin surface pH on palm, back of hand or wrists.

| Anatomical position | Correlation (r) | Significance (p) |
|---------------------|-----------------|------------------|
| Neck | -0.323 | 0.016 |
| Cheek | -0.462 | <0.001 |
| Forehead | -0.472 | <0.001 |

Discussion and Conclusion

- Dermal exposure to Ni, Co and PGMs in these refineries have been established:^{15,16}
 - other “cocktail” of chemicals, in particular acids (irritants).
- Skin surface pH of unprotected skin is weakly to moderately correlated with the acidic atmospheric environment in PMR.
- In all likelihood responsible for the altered skin barrier as evidenced by TEWL and reflected by low skin surface pH.
- SC hydration increase/decrease (inconclusive).
- Irritants paving the way for sensitiser permeation?¹⁷
- TEWL is more affected in BMRs, including packaging than in PMRs.
 - BMR more “open” processes than PMR.

Acknowledgements

This research was in part supported by the National Research Foundation of South Africa.

Any opinion, finding and conclusion or recommendation expressed in this material is that of the author(s) and the NRF does not accept any liability in this regard.



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Thank you

