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# Technical Analysis of the 505 Pitting Project - Surface in the Kamoto Mine

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**Abstract:** ***In order to analyze the 505-surface dewatering project in the KAMOTO mine, we quantified all the water inflows to zone 5 in order to allow us to properly size our new dewatering circuit. The maximum inflow to zone 5 is 890 m3/h. For circuit sizing; it was subdivided into two sections. For the first section (505-355), we obtained as total head losses equal to 10.98 m, which gives us a manometric height of 160.98 m. We have chosen 4 Flowserve pumps of the 150 NM type with a nominal flow rate of 250 m3/h and a head of 250 m which will be installed in parallel and 1 spare pump of the same type. Thus the operating point of a pump is (400; 150) and pumps in parallel is (1480; 175). As for the second section, the losses are 7.6 m which gives a height gauge of 362.6 m and we choose 2 Flowserve 201 NM type pumps with a nominal flow rate of 450 m3/h with a manometric head of 400 m which will be placed in parallel and 1 pump of the same type in reserve. Thus the operating point is (280; 355) for one pump and for the pumps in parallel (550; 360). And after sizing the decanter with flocculant, we obtained the following results: the lateral surface of the decanter is 423.81; the width 8 m and the length 50 m. To make it easier for the decanter to be cleaned at the same the moment the water was pumped, the settling tank was split into compartments; therefore the cleaning will take place without stopping the dewatering pumps. It will be done using BRAVO 400 type mud pumps.***

## 1. Introduction

The KAMOTO underground mine aims to ensure the production Planned 180,000 TS/year in complete safety. For this, there are several problems that will have to be solved in order to carry out this annual planning. Among these various problems, there is drainage.

The problem being based on the 505 dewatering of the KAMOTO underground mine, it will be a question of:

- Assess the quantity of water inflow to this area;
- Size the new circuit;
- Design the relay station (decanter + thin layer);
- Size the decanter (relay station); - provide for the cleaning of the decanter.

### Water Influx Assessment

The KAMOTO underground mine is supplied with water by:

- The KAMOTO Etang aquifer
- The KAMOTO South aquifer
- The KABULUNGU tablecloth
- The KAMOTO Roof ply
- The KOV tablecloth

In addition to these five aquifers, there are waters that come from hydraulic backfilling.

So to arrive at sizing our new circuit, we will be obliged to go through a quantification of inflows throughout the underground mine as well as those of the treated area. The influx of water that goes to the underground mine of KAMOTO is given in the tables below:

**Table 1:** Kamoto Etang aquifer inflow

| **Sources of water** | | | **AQUIFER KTO ETANG 2020-2021** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Level | Locate | Description | Oct-13 | Nov-13 | Dec-13 | Jan-14 | Feb14 | Mar14 | Apr-14 | May-14 | June-14 | July-14 | Aug-14 | Sept-14 |
| N.235 | CH W | seepage | 0,5 | 0.5 | 0,5 | 0,3 | 0,5 | 0,5 | 0,5 | 0,5 | 0,3 | 0,3 | | |
| N.265 | CH W | Seepage | 1 | 1 | 1 | 3,7 | 3 | 3 | 3 | 3 | 2,7 | 2,5 | | |
| N307 | TUNA | Crack | 529 | 526 | 526 | 444 | 355 | 348 | 365 | 327,42 | 308 | 291 | 216 | 205 |
| N385 | Ac32CTS | leak | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1,72 | 1,6 | 1,88 |
| N385 | AccBino | leak | 25,86 | 13.56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,48 | 7,13 |
| N400 | Ac20 | seepage | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1,6 | 1,4 |
| N403 | ChimneySimba | seepage | Nm | Nm | Nm | Nm | Nm | Nm | | | | | 15 | 13 |
| N415 | CTS | seepage | | Nm | Nm | Nm | Nm | Nm | 8,77 | 8,67 | **9** | **9** | 2 | 1,4 |
| N415 | OBI | Seepage | | Nm | Nm | Nm | Nm | Nm | 12,57 | 13,01 | 13,71 | 13 | 7,81 | 10,13 |
| N415 | AC 24 /CTS | seepage | | | | 25,15 | | | 13,59 | 16,48 | 14,72 | 15,42 | 13,24 | 13,12 |
| N.425 | ETANG | obturator | | | | | | | | | | | | |
| N.430 | ETANG | Hole | | Nm | Nm | Nm | Nm | Nm | | | | | 2 | 1 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N460 | Rampe 17 | Seepage | | | 18 | 3,85 | 23 | 21 | | | | | 21 | 23 |
| N445 | Main access North | Crack | 5,25 | 16.42 | 0 | 0 | 12,37 | 11,78 | 2 | 2 | 4 | 6 | 12 | 13 |
| N445 | Rampe 18 | Seepage | | | 4 | 9 | 5 | 5 | 5 | 6 | 5,71 | 5 | 12,77 | 6,41 |
| N460 | Z1 OBI | hole | 16,11 | 28.13 | 28 | 2 | 28,13 | 27,89 | | | | | 28,13 | 28,14 |
| N460 | Rp460-445 | Seepage | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| N475 | CTS | seepage | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1,2 | 1 |
| N.490 | INCLINE16 | Crack | 1.9 | 1.8 | 2 | 2 | 9 | 8 | 2 | 2 | 2 | 2 | 0 | 0 |
| N505 | T3/RP505 | borehole | | | 0 | 0 | 1,8 | 1,5 | 0 | 0 | 1,2 | 1 | 0 | 0 |
| N520 | T3 Wuna | obturator | 0,5 | 0.5 | 0 | 0 | 0,5 | 0,5 | 0 | 0 | 0 | 0 | 0 | 0 |
| N.460 | ETG OBS | Dry | 0 | 0 | | 3 | 0 | 0 | | | | | 4 | 5 |
| SUB TOTAL OF DIRTY Water | | | 583.12 | 590.91 | 584,50 | 498,85 | 443,30 | 432,17 | 417,43 | 384,08 | 366,34 | 349,94 | 346,83 | 331.61 |

Table 2. Hydraulic backfill inflow: `BACKFILLING WATER`

| Level | Locate | Description | Oct-13 | Nov-13 | Dec-13 | Jan-14 | Feb14 | Mar14 | Apr-14 | May-14 | June-14 | July-14 | Aug-14 | Sept-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sources of water | | | Flow (m3/h) | | | | | | | | | | | |
| N505 | Etang North T8-T13 | Seepage | 50 | 51 | 45 | 56 | 57 | 64 | 55 | 56 | 80 | 48 | 60 | 60 |
| N505 | CH11-12 -Zone1 OBI | Seepage | 50 | 49 | 48 | 52 | 55 | 51 | 47 | 53 | 60 | 47 | 45 | 74 |
| N505-490 | T0-T5 Etang North OBI | seepage | 50 | 49 | 47 | 43 | 63 | 86 | 57 | 44 | 39,32 | 45 | 65 | 33 |
| **SUBTOTAL OF BACKFILLING HYDRAULIC** | | | 150 | 149 | 140 | 151 | 175 | 201 | 159 | 153 | 179,32 | 140 | 170 | 167 |

**Table 3:** KOV aquifer inflow

| AQUIFER KOV 2020-2021 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sources of water** | | | **Flow (m3/h)** | | | | | | | | | | | |
| **Clear water** | | | | | | | | | | | | | | |
| Level | Locate | Description | Oct-13 | Nov-13 | Dec-13 | Jan-14 | Feb-14 | Mar-14 | Apr-14 | May-14 | June-14 | July-14 | Augu-14 | Sept-14 |
| N.276 | INCL 4 | obturator | Dry | Dry | Dry | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| N.285 | INCL 4 | obturator | 0 | 0 | Dry | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| N.273 | CHE | obturator | Dry 0 | Dry | 13 | 6,3 | 4,16 | 15,78 | 15,12 | 8,9 | 12,01 | 12 | 15 | 12 |
| N.300 | INCL 3bis | obturator | | | | | | | | | | | | |
| | | Seepage | | 0 | Dry | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| N.300 | INCL 4bis | obturator | Dry 0 | Dry | Dry | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Seepage | | 0 | | 0 | 17 | 15,15 | 16,15 | 13 | 12 | 13 | 0 | 0 |
| N.330 | CHE | obturator | 65,12 | 54.98 | 60,4 | 60 | 61 | 65 | 63 | 55 | 41 | 73 | 34,85 | 4 |
| | | Seepage | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 7 | 9 | 41 | 41 |
| N.345 | CHE | obturator | 132,47 | 132.23 | 144 | 144 | 142 | 140 | 138 | 135 | 131 | 130 | 75,58 | 90,02 |
| | | Seepage | 115,7 | 122.7 | 82 | 60 | 52,35 | 47,7 | 51 | 49 | 52,1 | 55 | 102 | 102 |
| N370 | CHE/incline9 | Leak | 12 | 12 | 13 | 13 | 12 | 12 | 11 | 11 | 9,81 | 9,12 | 59,49 | 51 |
| N415 | CHE RA400 | Leak | 13,25 | 10.11 | 11 | 11 | 10,2 | 11 | 10 | 8 | 8 | 53 | 53 | 1 |
| N.432 | INCL9(CON12) | obturator | 248,28 | 201.3 | 221 | 224 | 204,31 | 206 | 217 | 212 | 199,02 | 8 | 62,16 | 121 |
| | | Seepage | 2 | 2 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 126 | 1,8 | 6 |
| **TOTAL OF KOV(Clean water)** | | | **589.82** | **536.32** | **570,4** | **519,3** | **504,02** | **513,63** | 522,27 | 499,9 | 471,94 | 488,12 | 444,88 | 428.02 |

**Table 4:** Inflow from the South Kamoto aquifer

| **AQUIFER OF KTO/SUD 2020-2021** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SOURCES OF WATERS** | | | **Flow (m3/h)** | | | | | | | | | | | |
| Level | Locate | Description | Oct-13 | Nov-13 | Dec-13 | Jan-14 | Feb-14 | Mar-14 | Apr-14 | May-14 | June-14 | July14 | Augu-14 | Sept-14 |
| **Clear water** | | | | | | | | | | | | | | |
| N.207 | PUITS 4 | obturator | 93,45 | 96.23 | 90,97 | 111 | 91,36 | 95,76 | 95,93 | 95,36 | 94,38 | 76,2 | 61,35 | 54 |
| N.345 | RA200 | Seepage | 11,12 | 12.78 | 15 | 4,3 | 15,39 | 4,6 | 4,2 | 4,9 | 4,5 | 4 | 1 | 1 |
| N.345 | RA TOGO | obturator | 3,08 | 3 | 10,58 | 30 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | | Seepage | 22,89 | 24.71 | 28,33 | 2,5 | 16,2 | 13,5 | 14,6 | 15,02 | 12,1 | 13,12 | 11 | 12 |
| N.345 | RA400 | obturator | 1 | 1 | 4,27 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Seepage | 15,47 | 16.09 | 10,96 | 19,41 | 23,59 | 24,7 | 22,9 | 19,13 | 11,39 | 10,78 | 8 | 6 |
| N.345 | RA600 | Seepage | 0,5 | 0.5 | 0,5 | 0,5 | 0,5 | 0,5 | 0,3 | 0,3 | 0,3 | 0,3 | 0,5 | 0,5 |
| **TOTAL OF KTO/SUD (clear water)** | | | **147.51** | **154.31** | **160,93** | **169,71** | **151,24** | **145,06** | 144 | 140,71 | 128,67 | 110,4 | 87,85 | 79.5 |

**Table 5:** Kabulungu groundwater inflow

| SOURCES OF WATERS | | | AQUIFER OF KABULUNGU 2020-2021 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Level | Locate | Description | Oct-13 | Nov-13 | Dec-13 | Jan-14 | Feb-14 | Mar-14 | Apr-14 | May-14 | June-14 | July-14 | Aug-14 | Sept-14 |
| Clear water | | | | | | | | | | | | | | |
| | | | Flow (m3/h) | | | | | | | | | | | |
| N.357 | ANC/SON | borehole | 237.07 | 230.12 | 230,12 | 200 | 213,12 | 207 | 198 | 164 | 199 | 206 | 243 | 263 |
| N.357 | AP510W | borehole | | | | | | | | | | | | |
| N.357 | RP510W | obturator | | | | | | | | | | | | |
| N.357 | R 575 | Seepage | | | | | | | | | | | | |
| N.357 | CAS SCH | crack | 300 | 300.1 | 300,1 | 300 | 318,62 | 311 | 234 | 218,26 | 226 | 252 | 206 | 197 |
| TOTAL OF KABULUNGU (clear water) | | | 537.07 | 530.22 | 530,2 | 500 | 531,74 | 518 | 432 | 382,28 | 425 | 458 | 449 | 460 |

**Table 6:** Groundwater inflow from KAMOTO Roof

| | | | | | | AQUIFER OF KTO/TOIT 2020-2021 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Level | Locate | Description | Oct-13 | Nov-13 | Dec-13 | Jan-14 | Feb-14 | Mar-14 | Apr-14 | May-14 | Jun-14 | Jul-14 | Aug-14 | Sep-14 |
| Sources of water | | | | | | Flow (m3/h) | | | | | | | | |
| N.150 | INCL 1-2 | Hole | 20,57 | 21.39 | 16,47 | 18,95 | 17,65 | 1,91 | 2,1 | 1,24 | 1,5 | 19,5 | 4,18 | 3,2 |
| | | Seepage | | | 5 | 6 | | | | | | | | |
| N.207 | CH Mayi | Seepage | 1 | 1 | 1 | 1 | 6,3 | 1,72 | 1,89 | 10,12 | 7,2 | 2,5 | 0,5 | 0,5 |
| N.213 | INCLINE2 | Seepage | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | |
| N.240 | INCLINE2 | Seepage | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | |
| N.328 | CH.LAKI | Seepage | 1 | 1 | 1 | 1 | 13,97 | 1 | 1 | 1 | 1 | 1 | 0 | |
| N.357 | Puits3 | borehole | 3 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 4 | 4 | 3,5 | 3,22 |
| N.425 | ACC 180 W | Leak | | | 20 | 5 | | 5 | 6 | 6 | 7,2 | 11,13 | 21,74 | 20,12 |
| N505 | Rb1 | Seepage | 22 | 23.07 | 1 | 1 | 23,07 | 20,78 | 21,5 | 20,98 | 20,21 | 19,48 | 23,94 | 23,6 |
| | | borehole | 1 | 1 | 6 | 3 | 16,76 | 17,13 | 20,14 | 22 | 10,8 | 12,1 | 11,78 | 9,56 |
| N.505 | RB2 | Seepage | 20,85 | 21.2 | 35 | 14 | 21,2 | 20,1 | 20 | 18 | 18 | 19 | 12,59 | 12,72 |
| N505 | Chimney 1300 | Seepage | 5 | 5 | 5 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 2,5 | 2,5 |
| N505 | Rampe22 | Holeleft | 25,12 | 21.13 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| N505 | Rampe22/D29 S | Leak | | | 1 | | 19,69 | 18,99 | 11,55 | 8,75 | 8,17 | 12,29 | 0 | 0 |
| N505 | R21/D29M | | 59,2 | 55.68 | 10 | 8,71 | 32,94 | 31,73 | 31,85 | 32 | 33,56 | 30,44 | 35 | 36,7 |
| N505 | D29/R1 | hole | | | 0 | 0 | 20,57 | 21,13 | 24,97 | 21,23 | 7,15 | 28,18 | 25 | 22,7 |
| N505 | D29/Acc OBI 2 | holes | | | 61 | 19;73 | 3 | 2 | 1 | 1 | 1 | 1 | 15,05 | 13,78 |
| N505 | Rampe21/R5 | Seepage | 1,5 | 1.3 | 0 | 0 | 4 | 5 | 4 | 3,75 | 2 | 2 | 1 | 1 |
| TOTAL OF KTO/TOIT | | | 162.15 | 156.77 | 168,47 | 85,39 | 191,15 | 157,49 | 156 | 156,07 | 128,79 | 169.62 | 156.78 | 149.6 |
| GENERAL TOTAL | | | 2169.67 | 2117.53 | 2154,52 | 1924,25 | 1996,45 | 1967,35 | 1830.32 | 1716,02 | 1700,01 | 1716.08 | 1655 | 1616 |

**Table 7:** Inflow from the Fallen Zone to Zone 5

| | | | Afflux d’eau de la zone eboulée vers la zone 5 (505 L) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sources of water | | | Flow (m3/h) | | | | | | | | | | | |
| Level | Locate | Description | Oct -13 | Nov 13 | Dec -13 | Jan -14 | Feb -14 | Mar -14 | Apr -14 | May -14 | June -14 | July -14 | Aug -14 | Sept -14 |
| N505 | GL1 sond front | Borehole | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| N,505 | GL1/SOND parement | Borehole | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| N.505 | D29/Rampe 22 Sud | Crack (faille) | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| N.505 | Rampe 22 Toit | Borehole | 3 | 3 | 3 | 3 | 0 | 3 | 0 | 0 | 5 | 50 | 0 | 0 |
| N.505 | Rampe 22/CON 1 | Borehole | 85 | 83 | 83 | 83 | 80 | 65 | 29 | 28 | 95 | 76 | 81 | 78 |
| N,505 | KUMBWA | Seepage | 65 | 65 | 65 | 65 | 65 | 65 | 65 | 65 | 85 | 65 | 65 | 65 |
| GENERAL TOTAL | | | 153.5 | 151.5 | 151,5 | 151.5 | 145 | 133 | 94 | 93 | 185 | 201 | 146 | 143 |

**Table 8 :** General inflow from KAMOTO underground mine

| | KTO/ETANG | KTO/KOV | KABULUNGU | KTO/SUD | KTO/TOIT | BACKFILL | ZONE EBOULEE |
|---|---|---|---|---|---|---|---|
| Oct-20 | 582,12 | 589,82 | 537,07 | 147,51 | 162,15 | 150 | 153,5 |
| Nov-20 | 590,91 | 536,32 | 530,22 | 154,31 | 156,77 | 149 | 151,5 |
| Dec-20 | 584,5 | 570,4 | 530,2 | 160,93 | 168,47 | 140 | 151,5 |
| Jan-21 | 498,85 | 519,3 | 500 | 169,71 | 85,39 | 151 | 151,5 |
| Feb-21 | 443,3 | 504,02 | 531,74 | 151,24 | 191,15 | 175 | 145 |
| March-21 | 432,17 | 513,63 | 518 | 145,06 | 157,49 | 201 | 133 |
| Apr-21 | 417,43 | 522,27 | 432 | 144 | 156 | 159 | 94 |
| May-21 | 384,08 | 499,9 | 382,28 | 140,71 | 156,07 | 153 | 93 |
| Jun-21 | 366,34 | 471,94 | 425 | 128,67 | 128,79 | 179,32 | 185 |
| Jul-21 | 349,94 | 488,12 | 458 | 110,4 | 139,62 | 140 | 201 |
| Aug-21 | 346,83 | 444,88 | 449 | 87,85 | 156,78 | 170 | 146 |
| Sep-21 | 331,61 | 428,02 | 460 | 79,5 | 149,6 | 167 | 143 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TOTAL( m3/h) | 5328,08 | 6088,62 | 5753,51 | 1619,9 | 1808,3 | 1934,3 | 1748 |
| total flow ( m3/h) | 24280,7 | | | | | | |
| average flow (m3/h) | 3468,671429 | | | | | | |

Since the Kamoto mine is large, comprising several areas, our field of action is limited only to the dewatering Zone 5, level 505. Hence it will be a question of quantifying only the influx of water to zone 5 and not for the entire mine.

Water inflows to zone 5 come from the following locations:
- Kamoto roof ply
- Hydraulic backfilling (Back Fill)
- The collapsed or collapsed area which is fed by water inflows from the overflows of holding tanks and settling tanks of the main drainage 369, overflows of the holding tanks of the secondary drainage 465, leaks on the pipes, on the walls backfilled chambers, collapses of the sludge walls (hydraulic backfilling) and seepage in the walls of the galleries.

The influx of water that goes towards the treated area in the mine Kamoto underground are given in the table below:

**Table 9:** Influx from Zone 5

| | *KTO/TOIT* | *BACKFILL* | *Zone éboulée* |
|---|---|---|---|
| Oct-20 | 162.15 | 150 | 153 |
| Nov-20 | 156,77 | 149 | 151.5 |
| Dec-21 | 168.47 | 140 | 151.5 |
| Jan-21 | 85.39 | 151 | 151.5 |
| Feb-21 | **191.15** | 175 | 145 |
| Mar-21 | 157.49 | **201** | 133 |
| Apr-21 | 156 | 159 | 94 |
| May-21 | 156.07 | 153 | 93 |
| Jun-21 | 128.79 | 179.32 | 185 |
| Jul-21 | 169.62 | 140 | **201** |
| Aug-21 | 156.78 | 170 | 146 |
| Sep-21 | 149.6 | 167 | 143 |
| TOTAL (m3/h) | **1838.28** | **1934.32** | 1747.5 |
| Total flow (m3/h) | | **5520.1** | |
| Average flow (m3/h) | | **460.01** | |

The average inflow rate in Zone 5, 505 L is:
(1838.28 + 1934.32 + 1747.5) = 460.01 m3/h

In the rest of our work, as it is a question of sizing a new pumping circuit we will not use the average flow but rather the maximum flow in red (Cfr Table .2) of each aquifer supplying zone 5 during a period of 12 months (i.e. from October 2020 until September 2021 ). The maximum flows for each aquifer towards zone 5 are:

- for Kamoto roof: Q = 191.15 /h
- for hydraulic backfilling: Q = 201 /h
- for the collapsed area: Q = 201 /h Which gives us a maximum flow of:

Qmax = 191.15 + 201 + 201 = 593.15 /h

To the hydrogeology department of the Kamoto underground mine, for all Sizing, a safety factor of 1.5 is used.

Then we will have as the maximum value of the flow the following:
= 1.5 x 593.15 = 889.725 m3/h

And we will take as value = 890 /h

The dewatering rules recommend that the water pumping capacity per unit of time is greater than the water inflows of this same unit. At the limit where there is a tie, the water level will just be maintained at its starting point with all the risks incurred. And if not, drowning will be imminent if effective measures are not taken.

### 1.1 Circuit Sizing

A pumping circuit is characterized by a geometric height (Hg) (summation between the suction height and the discharge height), a length (L), the flow rate of the fluid (Q) and the components that constitute it.

The length of the piping as well as the accessories of the circuit creates pressure losses (ΔH). Thus, at discharge, the pump must overcome these pressure drops to discharge the fluid to the desired location.

With regard to the dimensioning, it is a question of pumping the water from zone 5, directly towards the surface on a path already evaluated using the Autocad software which is 2050 m.

The new circuit will start from level 505 directly to the surface via the following route:

- from GL3 (Holding) at level 505 to level 425 via chimney Rb 21 which connects the two levels;
- at 425, the circuit will take ramp 25 to level 355 where a decanter + outfit will be installed;
- from 355 to level 207 via chimney Rb 19 connecting the two levels;
- and 207 to the surface through boreholes.

The new circuit will be divided into two parts or sections, namely:

- From 505 L up to 355 L over a length of 1200 m with a geometric height of 150 m
- 355 L to the surface over a length of 850 m with a geometric height of 355 m

The figure below shows the diagram (in green) of the 505 dewatering project up to the surface.

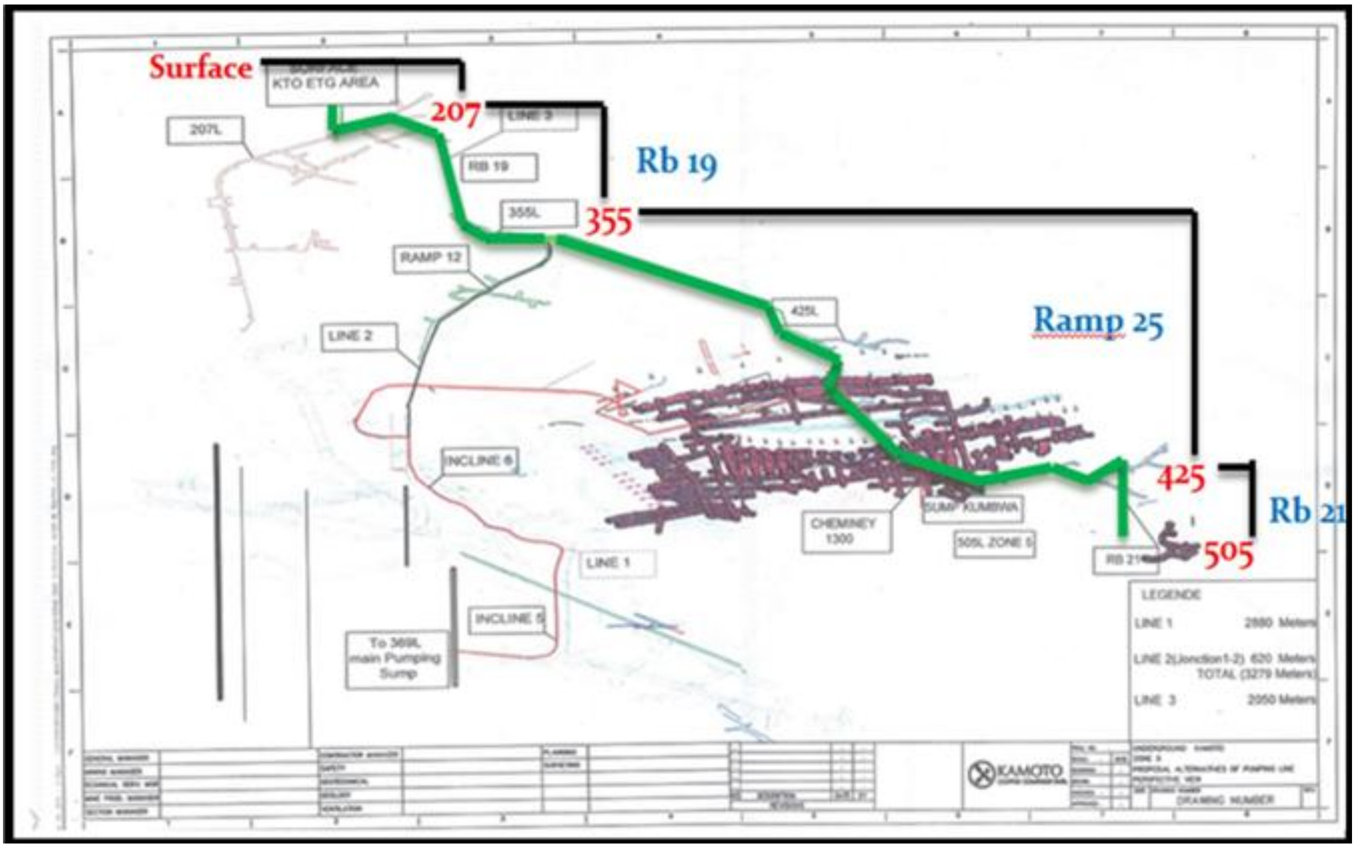

**Figure 3:** Diagram of the 505 dewatering project - surface

### 1.1.1 First section

We have as data:

- the length = 1200 m
- height difference = 150 m
- the maximum flow = 890

**a) The speed of water circulation in the pipes**

A speed of between 1.5 and 2.2 m/s is chosen to minimize the load losses. And if the water is very loaded with solid particles, it is advisable to take speeds close to 2 m/s. For our case we have chosen a speed of 2 m/s because the water in zone 5 is loaded with solid particles.

**b) The diameter of the pipe**

The diameter of the pipe is conditioned by the flow velocity and the flow. It is deduced from the following expression:

(m) (III.3)

= + 0.025 (m) (III.4)

With :

• : diameter of the discharge pipe []

• : diameter of the suction pipe []

• : the pumping rate []

• V: average water flow speed in the pipe [] In our case, the diameters are:

= 0.3968 m or 16 inches

= + 0.025 = 0.3968 + 0.025 = 0.4218 m or 17 inches

**c) Load losses**

The movement of a fluid in a pipeline implies the existence of a force that generates its movement. This force results from a pressure upstream of the network, which is commonly called the head of head. This load height is therefore variable depending on the location of the circuit.

In addition, under the effect of the friction of the fluid on the walls of the pipes and the obstacles encountered, this initial load decreases throughout the course. This is referred to as head losses.

The pressure drops depend on the material, the flow rate, the shape of the route, diameter and length of the pipes.

There are two types of head losses:

- Linear head losses due to friction of the fluid on the walls
- Singular head losses due to mishaps in the pipelines and obstacles (elbows, valves, etc.)

**Linear pressure drops**

They occur throughout the conduct and are deduced by the Darcy-Weisbach relation:

[m] (5) With:

$\lambda$: Darcy coefficient of friction. It is a function of the flow regime translated by the Reynold number (Re) given by the following relationship:

Re = (6) With:

V: Flow velocity [ ]

D: Pipe diameter [m]

Kinematic viscosity [ ] for water =

L: Pipe length [m]

NB: The conditions necessary to determine the type of flow regime according to the Reynold number (Re) as well as the determination of the pressure loss coefficient ($\Delta$) for each regime are as follows:

if Re = 2300: the regime is laminar hence:
Δ=Re/64 (7)

if 2300 < Re < 100,000: the regime is turbulent smooth
Δ = 0.316. (BLASIUS formula) (8)

if Re > 100,000: the regime is rough turbulent
Δ = 0.0032 + 0.221. (NIKURADSE formula) (9)

With:
- : dynamic viscosity kg/ms
- : density of Kamoto water 1.154. kg/

So
Re = 2 . 0.4218 / 8.6655. 10-7 > 2300
So we're dealing with a rough turbulent regime

The value of the linear pressure loss coefficient is:
Δ = 0.0032 + 0.221. = 0.0032 + 0.221. ( = 0.0116
So :
Δh asp=λ.La/Da.(Va.Va)/2g=0.0116.5/0.4218.2.2/2.10=0.0275 m

Δh ref=λ.Lref/Dref.(Vref.Vref)/2g; Re=(Vref.Vref)/v

Re=(2 .0.3968)/(8.6655. 〖10〗^(-7) )=915815.5906 >2300
So the regime is turbulent rough
The value of the linear pressure loss coefficient will be:
λ= 0.0032 + 0.221. = 0.0032 + 0.221. ( = 0.0117
Δh ref=λ.Lref/Dref. 〖Vref〗^2/2g=0.0117.1200/0.3968.2^2/2.10=7.0766m

## Singular pressure drops

They occur when the fluid passes through the accessories of the pipe, such as elbows, valves, section changes, etc.
They are given by the formula below:

h_sing^v=n.(kv^2)/2g [m] (11)

With :
n: number of accessories;
k: the pressure drop coefficient;
v: liquid velocity (m/s)
g: acceleration due to gravity (m/ ) Our circuit will include:
18 bends including: 9 bends of 90°; 5 elbows of 60° and 4 elbows of 22°
1 check valve
2 valves
1 strainer
Then the singular head losses become:

For a check valve (k=1):
h_sing1^v=n.(kv^2)/2g=1.1.2.2/2.10=0.2m

For 2 valves (k=1.5):
h_sing2^v=n.(kv^2)/2g=(2.1,5.2^2)/2.10=0.6m

For a strainer (K=1):
h_sing1^v=n.(kv^2)/2g=1.1.2.2/2.10=0.2m

For 9 bends of 90° (k=1.2):
h_sing4^v=n.(kv^2)/2g=(9.1,2.2^2)/2.10=2.16m

For 5 elbows of 60° (k=0.60):

h_sing5^v=n.(kv^2)/2g=(5.0,6.2^2)/2.10=0.6m

For 4 elbows of 22° (k=0.15):
h_sing6^v=n.(kv^2)/2g=(4.1,5.2^2)/2.10=0.12m

= + + + + +
= 0.2 + 0.6 + 0.2 + 2.16 + 0.6 + 0.12 = 3.88m

So the total losses are:
= + + = 0.0275 + 7.0766 + 3.88 = 10.98m

## Determination of manometric height

Manometric height means the sum of the geometric height and the pressure drops caused by internal friction which is formed when the liquid passes through the pipes, the pump and the hydraulic accessories. It is given by the following relationship:
= + (12) = 150 + 10.98 = 160.98m

## Choice of pumps

The choice of pumps for this section is conditioned by the flow maximum and the head obtained above.

The pump to be chosen must have a flow greater than 890 /h and a head greater than 160.98 m.

Depending on the above results, we choose the FLOWSERVE 150 NM type pump which has a nominal flow rate of 250 m3/h and a head of 250 m.

We will take 4 pumps which will be put in parallel of which 3 will work 24/24 h and one 12/24 h - 1 pump in reserve of the same type.

Determination of operating point 1

H=Hg+Δh. 〖(Qi/Qtot)〗^2 (12)

With Qtot = (250 x 4) = 1000 m3/h

**Table 10:** Calculation of head losses at different flow rates for section 1

| Qi | Hg | h | Qtot | Hm |
|---|---|---|---|---|
| 0 | 150 | 10.9841 | 1000 | 150 |
| 30 | 150 | 10.9841 | 1000 | 150.00989 |
| 60 | 150 | 10.9841 | 1000 | 150.03954 |
| 90 | 150 | 10.9841 | 1000 | 150.08897 |
| 120 | 150 | 10.9841 | 1000 | 150.15817 |
| 150 | 150 | 10.9841 | 1000 | 150.24714 |
| 180 | 150 | 10.9841 | 1000 | 150.35589 |
| 210 | 150 | 10.9841 | 1000 | 150.4844 |
| 240 | 150 | 10.9841 | 1000 | 150.63268 |
| 270 | 150 | 10.9841 | 1000 | 150.80074 |
| 300 | 150 | 10.9841 | 1000 | 150.98857 |
| 330 | 150 | 10.9841 | 1000 | 151.19617 |
| 360 | 150 | 10.9841 | 1000 | 151.42354 |
| 390 | 150 | 10.9841 | 1000 | 151.67068 |
| 420 | 150 | 10.9841 | 1000 | 151.9376 |
| 450 | 150 | 10.9841 | 1000 | 152.22428 |
| 480 | 150 | 10.9841 | 1000 | 152.53074 |
| 510 | 150 | 10.9841 | 1000 | 152.85696 |
| 540 | 150 | 10.9841 | 1000 | 153.20296 |

| | | | | |
|---|---|---|---|---|
| 570 | 150 | 10.9841 | 1000 | 153.56873 |
| 600 | 150 | 10.9841 | 1000 | 153.95428 |
| 630 | 150 | 10.9841 | 1000 | 154.35959 |
| 660 | 150 | 10.9841 | 1000 | 154.78467 |
| 690 | 150 | 10.9841 | 1000 | 155.22953 |
| 720 | 150 | 10.9841 | 1000 | 155.69416 |
| 750 | 150 | 10.9841 | 1000 | 156.17856 |
| 780 | 150 | 10.9841 | 1000 | 156.68273 |
| 810 | 150 | 10.9841 | 1000 | 157.20667 |
| 840 | 150 | 10.9841 | 1000 | 157.75038 |
| 870 | 150 | 10.9841 | 1000 | 158.31387 |
| 900 | 150 | 10.9841 | 1000 | 158.89712 |
| 930 | 150 | 10.9841 | 1000 | 159.50015 |
| 960 | 150 | 10.9841 | 1000 | 160.12295 |
| 990 | 150 | 10.9841 | 1000 | 160.76552 |
| 1020 | 150 | 10.9841 | 1000 | 161.42786 |
| 1050 | 150 | 10.9841 | 1000 | 162.10997 |
| 1080 | 150 | 10.9841 | 1000 | 162.81185 |
| 1110 | 150 | 10.9841 | 1000 | 163.53351 |
| 1140 | 150 | 10.9841 | 1000 | 164.27494 |
| 1170 | 150 | 10.9841 | 1000 | 165.03613 |
| 1200 | 150 | 10.9841 | 1000 | 165.8171 |
| 1230 | 150 | 10.9841 | 1000 | 166.61785 |
| 1260 | 150 | 10.9841 | 1000 | 167.43836 |
| 1290 | 150 | 10.9841 | 1000 | 168.27864 |
| 1320 | 150 | 10.9841 | 1000 | 169.1387 |
| 1350 | 150 | 10.9841 | 1000 | 170.01852 |
| 1380 | 150 | 10.9841 | 1000 | 170.91812 |
| 1410 | 150 | 10.9841 | 1000 | 171.83749 |
| 1440 | 150 | 10.9841 | 1000 | 172.77663 |
| 1470 | 150 | 10.9841 | 1000 | 173.73554 |
| 1500 | 150 | 10.9841 | 1000 | 174.71423 |
| 1530 | 150 | 10.9841 | 1000 | 175.71268 |
| 1560 | 150 | 10.9841 | 1000 | 176.73091 |
| 1590 | 150 | 10.9841 | 1000 | 177.7689 |
| 1620 | 150 | 10.9841 | 1000 | 178.82667 |
| 1650 | 150 | 10.9841 | 1000 | 179.90421 |
| 1680 | 150 | 10.9841 | 1000 | 181.00152 |
| 1710 | 150 | 10.9841 | 1000 | 182.11861 |
| 1740 | 150 | 10.9841 | 1000 | 183.25546 |
| 1770 | 150 | 10.9841 | 1000 | 184.41209 |
| 1800 | 150 | 10.9841 | 1000 | 185.58848 |

Figure (2.) below gives us the curves of the flows according to the manometric heights of the network (in red), the pump (in blue) and the pumps placed in parallel (in green).

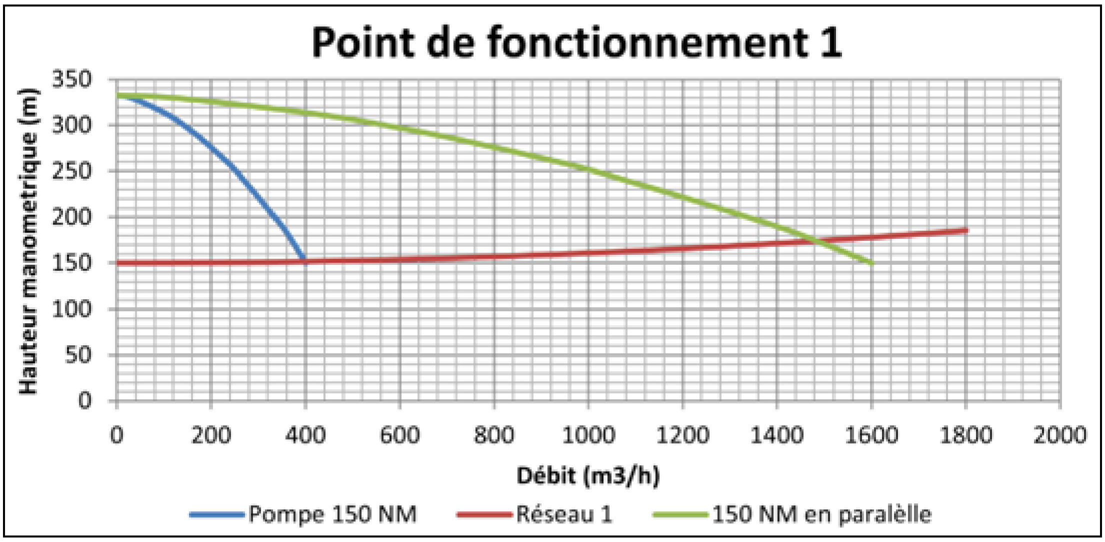

**Figure 2:** Section 1 operating point

Thus we obtain our operating point of a pump at (400; 150) and that of the pumps placed in parallel at (1480; 175) in the figure above.

### 1.2 Second section

We have as data:

- The length = 850 m
- Height difference = 355 m
- The maximum flow = 890

**a) The speed of water circulation in the pipes**

We have always chosen a speed of 2 m/s because we assume that the water is loaded with solid particles.

**b) The diameter of the pipe**

The water speed and the max flow does not change, we will take always Dr = 0.3968 m or 16 inches and Da = 0.4218 m or 17 inches.

**c) Load losses**

Linear pressure drops

Re = 2300 the regime is turbulent rough

The value of the linear pressure loss coefficient is:

$$\square = 0{,}0032 + 0{,}221.\ Re^{-0{,}237} = 0{,}0032 + 0{,}221.\ (973515{,}6656\ )^{-0{,}237} = 0{,}0116$$

- Then $h_{lin_{asp}} = \lambda.\frac{L_a}{D_a}.\frac{{V_a}^2}{2g} = 0{,}0116.\frac{5}{0{,}4218}.\frac{2^2}{2\ .\ 10}$ **= 0,0275 m**
- $h_{lin_{ref}} = \lambda.\frac{L_{ref}}{D_{ref}}.\frac{{V_{ref}}^2}{2g}$ ; Re = $\frac{V_{ref}.D_{ref}}{v}$

Re = $\frac{2\ .\ 0{,}3968}{8{,}6655\ .\ 10^{-7}} = 915815{,}5906 >$ 2300

So the regime is turbulent rough

The value of the linear pressure loss coefficient will be:

□ = 0,0032 + 0,221. $Re^{-0,237}$ = 0,0032 + 0,221. $( 915815,5906 )^{-0,237}$ = 0,0117

Then $\Delta h_{lin_{ref}} = \lambda.\frac{L_{ref}}{D_{ref}}.\frac{{V_{ref}}^2}{2g} = 0,0117.\frac{850}{0,3968}.\frac{2^2}{2.10}$= **5,0126 m**

Singular pressure drops

They are given by the formula below:

$h_{sing}$ =n. k . $\frac{V^2}{2g}$

Our circuit (Section 2) includes:
- 7 bends including: 6 bends of 90°; 1 elbow of 60°
- 1 check valve
- 2 valves
- 1 strainer

Then the singular head losses are worth:
for a check valve
(k=1): = 0.2m
⎱ for 2 valves (k=1.5)
⎱: = 2. 1.5 . = 0.6m
⎱ for a strainer (K=1)
⎱: = 0.2m
⎱ for 6 bends of 90° (k=1.2): = 6. 1.2 . = 1.44m
⎱ for 1 elbow of 60° (k=0.60): = 1. 0.60 . = 0.12m
= + + + +
= 0.2 + 0.6 + 0.2 + 1.44 + 0.12 = 2.56m
So the total losses are:
= + + = 0.0275 + 5.0126 + 2.56= 7.6m

### d) Determination of the manometric head

= + = 355 + 7.6001 = 362.6m

### e) Choice of pumps

The choice of pumps for this section is also conditioned by the flow maximum and the manometric height.
The pump to be chosen must have a flow greater than 890 m3/h and a head greater than 362.60 m.
Based on these results, we choose the FLOWSERVE 201 NM pump which has a nominal flow rate of 450 /h and a head of 400 m.

We will take 2 FLOWSERVE 201 NM pumps which will be put in parallel (24/24) - 1 reserve pump of the same type.

### f) Determination of operating point 2

H = Hg + $h\left(\frac{Qi}{Qtot}\right)^2$ Avec Qtot = 450 x 2 = 900 $m^3$/h

**Table III.11:** Calculation of head losses at different flow rates for section 2

| Qi | Hg | h | Qtot | Hm |
|---|---|---|---|---|
| 0 | 355 | 7.6001 | 900 | 355 |
| 30 | 355 | 7.6001 | 900 | 355.008445 |
| 60 | 355 | 7.6001 | 900 | 355.033778 |
| 90 | 355 | 7.6001 | 900 | 355.076001 |
| 120 | 355 | 7.6001 | 900 | 355.135113 |
| 150 | 355 | 7.6001 | 900 | 355.211114 |
| 180 | 355 | 7.6001 | 900 | 355.304004 |
| 210 | 355 | 7.6001 | 900 | 355.413783 |
| 240 | 355 | 7.6001 | 900 | 355.540452 |
| 270 | 355 | 7.6001 | 900 | 355.684009 |
| 300 | 355 | 7.6001 | 900 | 355.844456 |
| 330 | 355 | 7.6001 | 900 | 356.021791 |
| 360 | 355 | 7.6001 | 900 | 356.216016 |
| 390 | 355 | 7.6001 | 900 | 356.42713 |
| 420 | 355 | 7.6001 | 900 | 356.655133 |
| 450 | 355 | 7.6001 | 900 | 356.900025 |
| 480 | 355 | 7.6001 | 900 | 357.161806 |
| 510 | 355 | 7.6001 | 900 | 357.440477 |
| 540 | 355 | 7.6001 | 900 | 357.736036 |
| 570 | 355 | 7.6001 | 900 | 358.048485 |
| 600 | 355 | 7.6001 | 900 | 358.377822 |
| 630 | 355 | 7.6001 | 900 | 358.724049 |
| 660 | 355 | 7.6001 | 900 | 359.087165 |
| 690 | 355 | 7.6001 | 900 | 359.46717 |
| 720 | 355 | 7.6001 | 900 | 359.864064 |
| 750 | 355 | 7.6001 | 900 | 360.277847 |
| 780 | 355 | 7.6001 | 900 | 360.70852 |
| 810 | 355 | 7.6001 | 900 | 361.156081 |
| 840 | 355 | 7.6001 | 900 | 361.620532 |
| 870 | 355 | 7.6001 | 900 | 362.101871 |
| 900 | 355 | 7.6001 | 900 | 362.6001 |

The figure below gives us the curves of the flows according to the manometric heads of network 2 (in red), of the pump (in blue) and of the pumps placed in parallel (in green).

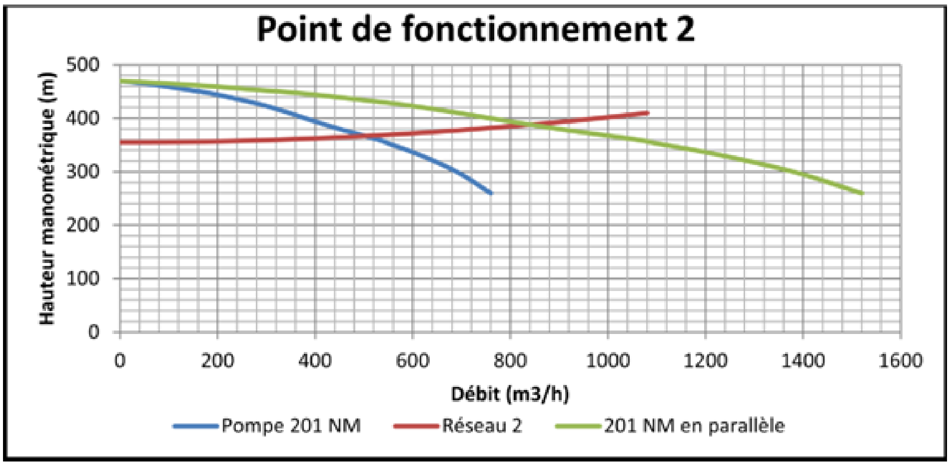

**Figure 3:** Operating point of section pumps

Thus we obtain our operating point of a pump at (280; 355) and pumps placed in parallel at (550; 360) in the figure above.

### 1.3 Relay Station Design. (GEOFFREY, 2012)

A relay station on level 355 will allow us to retain solid particle-laden water from the 505 level of Zone 5 of the Kamoto underground mine. This station will allow the decantation of these solid particles by improving the quality of the water and the pumping at level 355.

These particles will accumulate at the bottom of the basin, from where they will be extracted periodically by cleaning. The water collected on the surface is said to be clarified and will then be pumped to the upper levels.

In the design of a settling pond (decanter) in a mine underground, we opt for the rectangular longitudinal shape because it has a technical simplicity that requires little maintenance and unskilled labor.

In an underground mine, the construction of a settling basin requires that the surrounding rock be of good resistance and impermeable so that the settling can take place in good conditions. Otherwise, we are forced to project the concrete to make the rock waterproof.

For it to have decantation of the particles in suspension in the water, it

The falling speed of the particles should be greater than the horizontal speed of the water in the basin, in other words the time required for the particles to settle to reach the bottom should be less than the time required for the liquid to cross the settler horizontally.

### 1.3.1. Sizing of the decanter

The decanter will have an ideal rectangular shape below:

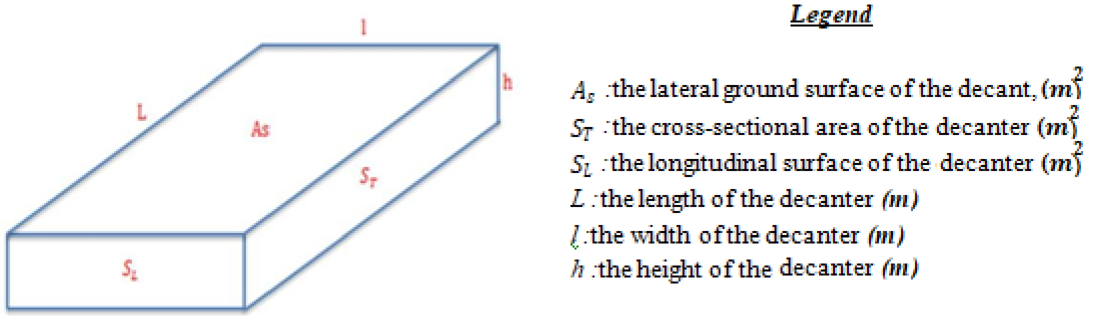

**Figure III.4:** Shape of an ideal

We have as data:

- The water temperature: T° water = 20° C
- The density of water: = 1.154. Kg/
- Density of solids: = 2600 Kg/
- The acceleration of gravity: g=10 m/

The decanter must be such that at least the 10 µm particles of diameter are retained. Indeed, according to the manufacturer of FLOWSERVE pumps, water becomes abrasive when its suspended solids content exceeds 10 mg/l with a diameter of 10 µm.

Moreover, such a particle is retained if and only if the time of settling is less than the residence time. (Td < Ts) with:
We get the following relationship:
(III.12)

With:
- h: the height of the decanter (m)
- : the limit speed of fall of solid particles (m/s)
- : length of the decanter (m)
- : fluid velocity (m/s)

**a) Settling time (td)**

The limit speed of fall of the particle is given by the following relation:

(m/s) (III.13)

With :
- g: acceleration due to gravity (m/ )
- : density of solids (kg/ )
- : density of Kamoto water (kg/ )
- = the dynamic viscosity of water (Pa.s) The limiting speed of fall is then:

m/s

Since the efficiency of a decanter does not depend on the depth, so we assumed that the height is 1 m

So the settling time is:

$$\text{Td} = \frac{h}{V_L} = \frac{1}{8{,}017298736.10^{-5}} = 12448,$$

13278 s = 3 hours 30 mins

**b) Residence time (Ts)**

The lateral ground surface of the decanter As is given by the relation below
below [MAPAQ, 1990]:
As = ø. (III.13)
With :
- ø: the adjustment factor linked to the turbulence. For security reasons we take 1.5

So As = 1.5. = 4625.4149
In general for a rectangular decanter, the ratio of the width (l) over length (L) is 1/6. (ENSEE, 2012):
Hence → L = 6.l (III.14)
Or As = L. l = 6. → l = m
Then L = 6.l = 6. 27.7651 = 166.59 m
Ts = hours 12 min
This satisfies the settling condition.

A decanter having enormous dimensions would entail a high cost of digging and stability problems (its support would be very expensive). To remedy this problem, we resort to the use of flocculants which allow us to accelerate the decantation (the decantation speed) and thus reduce the dimensions of the decanter.

**c) Sizing decanter with a flocculant**

The flocculant used is an anionic flocculant (GELBOCK 5H4/Y26/S/ZA/TE 7222) which is white in color, a concentration of 4 g/l, a dilution rate of 10 and is in the form of solid grains.

In order to speed up the settling time, we did a test to see how this flocculant will behave and thus determine the settling rate.

**Settling test**

**Materials used**

- The 1000 ml stemmed glass;
- 125 ml bottles;
- Filter papers for solids;
- Mechanical stirrer;
- A wash bottle;
- An electronic scale;
- An oven; - A stopwatch;
- A separatory funnel.

Operating mode

- Take 650ml of water containing solid particles in suspension and place it in the graduated burette
- Take 2.8g of solid flocculant and mix it with 50ml of clear water;
- Gradually pour the flocculant solution into the burette containing water with the solids in suspension
- Time the time for the water to clear.
- Withdraw 100 ml of the clear solution for the determination of the quantity of solids remaining;
- filter the sample to retain solids;
- Place the previously weighed filter paper in an oven heated to 100°C for 45 minutes;
- Determine the quantity of solids retained on filter paper by weight difference.
- Repeat this procedure for 0; 1; 2; 3; 4; 5 minutes

Presentation of the results

The tests were carried out with a volume of 700 ml of water with a dose of flocculant of 4g/l.

- For t = 0 min, we have a solid content of 462 g/l
- For t = 1 min, the solid content is 123 g/l
- For t = 2 min, the content becomes 10 g/l
- For t = 3 min, the solid content is 8 g/l

For t = 4 min, it is 8g/l
For t = 5 min, the solid content is 7 g/l

Looking at the results of our settling tests, we find that after 2 minutes, there is already almost 10 g/l of solid content remaining, therefore 452 g/l of solid eliminated, which makes approximately 97% of the settled solids. The tests were carried out with 700 ml of water using a 1000 ml burette measuring 150 mm in height; which gives a water column of 105 mm. And since settling already occurs after 2 min, the settling rate using this flocculant is equal to:

= 0.000875 m/s

The side surface of the decanter becomes:
Ace =
The width of the decanter and the length are respectively:
l = m and L = 6. 8.4 ≅ 50 m

### 1.4 Decanter cleaning

The cleaning of the decanters is done using mud pumps. For the Kamoto underground mine, we will use BRAVO type mud pumps.

The cleaning of the decanter (the relay station) must meet certain underground mine requirements.

To facilitate cleaning, we suggest compartmentalising the decanter as shown in the figure below:

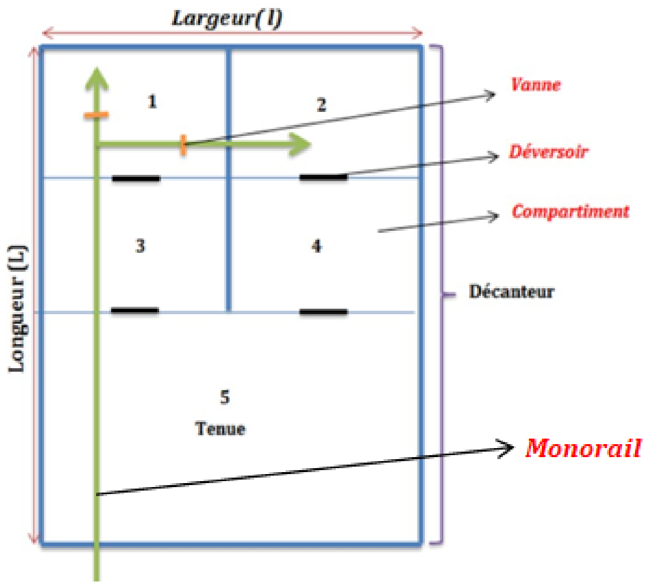

**Figure 3: 5** Lateral section of the decanter

**Decanter presentation**

- The decanter is subdivided into 5 compartments
- Compartment 5 represents the outfit where the suction pipes will be placed, which will be used to discharge clear water to the upper levels
- Compartments 1 and 2 will receive water from lower levels
- The first settling is done in 1 and 2; then the second will be done in 3 and 4 to finally have clear water in compartment 5;
- Between compartments 1 and 3 and 3 and 5 there will be a small passage of water to 3 and from 3 to 5 which will be placed in a staircase to prevent a reversal of the water already decanted in the rear compartments. We will do the same between 2 to 4 and from 4 to 5.

**Cleaning procedure**

To avoid the stoppage of all pump installations (pumps andmotors) at the time of cleaning, the cleaning is planned as follows:

¬ Cleaning of part 1 (Compartment 1 and 3)

- Pump the water back into compartments 1 and 2;
- Isolate the first part to be cleaned consisting of compartments 1 and 3 by stopping valve 1 and leaving valve 2 open;
- Place a FLYGT pump in compartment 1 then 3;
- Pump the water from two compartments (1 and 3) until it reaches the sludge level;
- Remove the FLYGT pumps;
- Place the discharge pipe and install the BRAVO mud pump on a monorail previously placed during the installation of the decanter used to slide the cleaning mud pump towards compartments 1 and 3;
- Connect the mud pump to the delivery pipe;
- Spray the working water and start pumping until the decanter compartment is emptied;
- Free compartments 1 and 3 by removing all cleaning equipment and open valve 1.
- Cleaning of part 2 (Compartment 2 and 4)
- Isolate the second part by closing valve 2;
- Move the cleaning equipment to the side of the second part;
- Pump the water from 2 and 4 until it reaches the mud using the FLYGT pumps;
- Move the discharge pipe to compartments 2 and 4;
- Install the BRAVO mud pump, always using the monorails which will be used to slide the mud pump towards 2 and 4;
- Connect the mud pump to the delivery pipes;
- Spray the working water and start pumping the sludge until compartments 2 and 4 are emptied;
- Release compartments 2 and 4; - Open valve 2.

## 2. Conclusion

The 505-surface dewatering project in the KAMOTO mine allowed us to quantify all the water inflows to zone 5 in order to allow us to properly size our dewatering circuit. The maximum influx to zone 5 being well determined, this allowed us to properly size the circuit; this circuit is divided into two sections. This leads us for the first section to choose 4 Flowserve pumps of the 150 NM type, which has a nominal flow rate of 250 m3/h and a manometric head of 250 m, which will be installed in parallel and 1 spare pump of the same type. As for the second section, we choose 2 Flowserve type 201 NM pumps with a nominal flow rate of 450 m3/h with a head of 400 m which will be placed in parallel and 1 pump of the same type in reserve. And after sizing the decanter with flocculant, we obtained The following results: the lateral surface of the decanter is 423.81; the width 8 m and the length 50 m.

To make it easier for the decanter to be cleaned at the same the moment the water was pumped, the decanter was split into compartments; therefore the cleaning will take place without stopping the dewatering pumps. It will be done using BRAVO 400 type mud pumps.

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