APPENDIX - I

```
CLS
OPEN "c:\psk\tab47.csv" FOR OUTPUT AS #1
REM
*************************************************************************
REM *                                                                   *
REM *          This program calculates the flowrate by the present      *
REM *                theoretical model                                  *
REM *                                                                   *
REM *                  TABLE 4.7                                        *
REM *                                                                   *
REM *                                                                    *
*************************************************************************

FOR I = 1 TO 102
READ BS, QA, PTF, TEMP, RS, GOR, FW
DENO = .78: DENG = .82:  Z1 = .89: K = 1.4:
DENO = DENO * 62.4: DENW = 62.4 * 1.07
QA = (1 - FW) * QA
BO = (1 + (.0033 * (TEMP - 60)) / DENO ^ 1.8297) * (1 + .00048 * RS)
BG = 14.7 * (TEMP + 460) * Z1 / (PTF * 520)
DENG = .0765 * DENG / BG
FO = 1 - FW
K1 = (K - 1) / K
B = (BO + FW)
A = DENO + RS * DENG / 5.615 + FWO * DENW
C = (GOR - RS) / 5.615 * (TEMP + 460) * 14.7 * Z1 / (PTF * 520)
QO1 = .758 * (BS / 12 / 64) ^ 2 * 3.21 / 4
QO2 = (K * (2 / (K + 1)) ^ ((K + 1) / (K - 1)))
QO3 = (QO2 * 32.2 * (PTF * A) / (B * (C + 1))) ^ .5 / ((B + C) * A)
QO = QO1 * QO3 * 86400 * 144 / 5.615
DIFF = (QO - QA) * 100 / QA
DIF = DIF + (DIFF / 102) ^ 2
PRRO = PRRO + ABS(DIFF)
DIF20 = DIF20 + (DIFF) ^ 2
IF I = 1 OR I = 36 OR I = 71 THEN
PRINT CHR$(12)
PRINT "  TABLE 4.8 SURFACE CHOKE FLOWRATE PREDICTION BY THE
PRESENT THEORETICAL MODEL"
PRINT ""
PRINT CHR$(14); "-------------------------------------------------------------------"
PRINT CHR$(14); "   TEST NO.   MEASURED     PREDICTED     PERCENT"
PRINT CHR$(14); "              FLOWRATE     FLOWRATE      RELATIVE"
PRINT CHR$(14); "               BBLS/D       BBLS/D       ERROR   "
PRINT CHR$(14); "-------------------------------------------------------------------"
```

```
PRINT
END IF
REM END IF
PRINT I; ","; BS; ","; PTF; ","; TEMP; ","; RS; ","; GOR; ","; QA; ","; QO;
","; DIFF; FW
NEXT I
PRR = PRRO / (I - 1)
SDD = SQR((DIF20 - I * DIF) / (I - 2))

PRINT "-----------------------------------------------------"
PRINT
PRINT " AVERAGE PERCENTAGE ERROR = "; PRR
PRINT
PRINT " STANDARD DEVIATION      = "; SDD
PRINT
PRINT "-----------------------------------------------------"
END
```

```
CLS
OPEN "C:\PSK\TAB48.CSV" FOR OUTPUT AS #1
REM
*************************************************************************
REM *    THIS PROGRAM CALCULATES THE FLOWRATE THROUGH
                        SURFACE CHOKES                              *
REM *                    BY OMANA MODEL                             *
REM *                                                               *
REM *                    TABLE 4.8                                  *
REM *                                                              *
REM
*************************************************************************
SIGL = 66
FOR I = 1 TO 102
READ DC, QA, PTF, TEMP, RS, GOR
DENO = .78: DENG = .82: Z1 = .89
BO = (1 + (.00033 * (TEMP - 60)) / DENO ^ 1.8297) * (1 + .00048 * RS)
BG = 14.7 * (TEMP + 460) * Z1 / (PTF * 520)
DENG1 = .0765 * DENG / BG
DENO = DENO * 62.4
NP1 = 1.74 * 10 ^ 4 * PTF * 10 ^ -6 / (DENO * SIGL) ^ .5
R = GOR
QD = 1 / (1 + R)
NR = DENG / DENO
ND = 120.872 * DC * (DENO / SIGL) ^ .5 / (12 * 64)
NQL = .263 * NR ^ -3.49 * NP1 ^ 3.19 * ND ^ 1.8 * QD ^ .657
QO = NQL / (1.84 * (SIGL / DENO) ^ 1.25)
QO = QO
DIFF = (QA - QO) * 100 / QA
DIF = DIF + (DIFF / 102) ^ 2
PRRO = PRRO + DIF
DIF20 = DIF20 + (DIFF / 102) ^ 2
IF I = 1 OR I = 36 OR I = 71 THEN
PRINT CHR$(12)
PRINT "  TABLE 4.9 SURFACE CHOKE FLOWRATE PREDICTION BY
OMANA  MODEL"
PRINT ""
PRINT "-------------------------------------------------------------------------------"
PRINT "  TEST NO.     MEASURED          PREDICTED       PERCENT "
PRINT "                FLOWRATE          FLOWRATE       RELATIVE"
PRINT "                 BBLS/D             BBLS/D         ERROR   "
PRINT "-------------------------------------------------------------------------------"
PRINT
END IF
```

```
PRINT #1, I; ","; QA; ","; QO; ","; DIFF
NEXT I
PRR = PRRO / (I - 1)
SDD = SQR(ABS(DIF20 - I * DIF) / (I - 2))
PRINT "------------------------------------------------------"
PRINT
PRINT #1, " AVERAGE PERCENTAGE ERROR = "; PRR
PRINT
PRINT #1, " STANDARD DEVIATION      = "; SDD
PRINT
PRINT "------------------------------------------------------"
END
```

```
OPEN "C:\PSK\TAB49.CSV" FOR OUTPUT AS #1
CLS
REM
*************************************************************************
REM *                                                       *
REM *    THIS PROGRAM CALCULATES THE FLOWRATES THROUGH
SURFACE CHOKE    *
REM *                    BY POETTMANN AND BECK MODEL            *
REM *                                                       *
REM *                TABLE 4.9                          *
REM
*************************************************************************
FOR I = 1 TO 102
READ BS, QA, PTF, TEMP, RS, GOR,FW
DENO = .78: DENG = .82 : Z1 = .89
BO = (1 + (.00033 * (TEMP - 60)) / DENO ^ 1.8297) * (1 + .00048 * RS)
BG = 14.7 * (TEMP + 460) * Z1 / (PTF * 520)
REM PRINT BO; DENG; DENO; BG
DENG1 = .0765 * DENG / BG
DENO = DENO * 62.4
ALPA = .00504 * (GOR - RS) * (TEMP + 460) * Z1 / (BO * PTF)
FO = 1 - FW
DENLSC = DENO * FO + DENW * FW
DENM = 5.614 * DENLSC + .0765 * DENG1 * GOR
ML = 1 / (1 + ((DENG1 * ALPA) / DENLSC))
VL = ML / DENLSC
ZZ = 86400 * 3.14 * 1.03 * (BS / (12 * 64)) ^ 2 / DENM
XX = SQR((9273.599 * PTF) / (VL * (1 + .5 * ML)))
YY = .4513 * SQR(ALPA + .766) / (ALPA + .5663)
QO = ZZ * XX * YY
DIFF = (QA - QO) * 100 / QA
REM PRINT USING "######"; I; PTF; PTFC; DIFF
DIF = DIF + (DIFF / 102) ^ 2
PRRO = PRRO + DIFF
DIF20 = DIF20 + (DIFF) ^ 2
IF I = 1 OR I = 36 OR I = 71 THEN
PRINT CHR$(12)
PRINT #1, "  TABLE 4.9 PREDICTION BY THE POETTMAN AND BECK
MODEL"
PRINT ""
PRINT "-------------------------------------------------------------------------"
PRINT "  TEST NO.     MEASURED          PREDICTED      PERCENT "
PRINT "                FLOWRATE          FLOWRATE       RELATIVE"
PRINT "                BBLS/D            BBLS/D         ERROR"
```

```
PRINT "-------------------------------------------------------------------------------"
PRINT
END IF
PRINT #1, I; ","; QA; ","; QO; ","; DIFF
NEXT I
PRR = PRRO / (I - 1)
SDD = SQR(ABS(DIF20 - I * DIF) / (I - 2))
PRINT "-------------------------------------------------------"
PRINT
PRINT #1, " AVERAGE PERCENTAGE ERROR = "; PRR
PRINT
PRINT #1, " STANDARD DEVIATION      = "; SDD
PRINT
PRINT "-------------------------------------------------------"
END
```

```
CLS
OPEN "C:\PSK\TAB410.CSV" FOR OUTPUT AS #1
REM
*************************************************************************
REM *                                                                   *
REM *    THIS PROGRAM CALCULATES THE FLOWRATES THROUGH                  *
REM *                                SURFACE CHOKES                     *
REM *                                BY ASHFORD MODEL                   *
REM *                                                                   *
REM *                                TABLE 4.10                         *
REM
*************************************************************************
FOR I = 1 TO 102
READ BS, QA, PTF, TEMP, RS, GOR,FW
DENO = .78: DENG = .82:   Z1 = .89
BO = (1 + (.00033 * (TEMP - 60)) / DENO ^ 1.8297) * (1 + .00048 * RS)
BG = 14.7 * (TEMP + 460) * Z1 / (PTF * 520)
REM PRINT BO; DENG; DENO; BG
A = .54 / 1000 * (TEMP + 460) * Z1 * (GOR - RS)
DENG1 = .0765 * DENG / BG
DENO = DENO * 62.4
FO = 1 - FW
B = 62.4 * (DENO * FO + DENW * FW)
BETA = 1 / (SQR(BO + FW))
QO1 = BETA * (BS / 64) ^ 2 / (A / PTF + .56)
QO2 = (B + .01353 * DENG1 * GOR) ^ 2 / (B + .01353 * DENG1 * RS)
QO = .858 * QO1 * SQR((A + .76 * PTF) / QO2)
QO = QO * 86400 / 5.615
DIFF = (QA - QO) * 100 / QA
REM PRINT USING "######"; I; PTF; PTFC; DIFF
DIF = DIF + (DIFF / 102) ^ 2
PRRO = PRRO + DIFF
DIF20 = DIF20 + (DIFF) ^ 2
IF I = 1 OR I = 36 OR I = 71 THEN
PRINT CHR$(12)
PRINT #1, "  TABLE 4.10 SURFACE CHOKE FLOWRATE PREDICTION BY
ASHFORD MODEL"
PRINT ""
PRINT "-------------------------------------------------------------------------"
PRINT "    TEST NO.      MEASURED      PREDICTED    PERCENT  "
PRINT "                  FLOWRATE      FLOWRATE     RELATIVE"
PRINT "                   BBLS/D        BBLS/D       ERROR   "
PRINT "-------------------------------------------------------------------------"
PRINT
END IF
```

```
PRINT #1, I; ","; QA; ","; QO; ","; DIFF
NEXT I
PRR = PRRO / (I - 1)
SDD = SQR(ABS(DIF20 - I * DIF) / (I - 2))
PRINT "-------------------------------------------------------"
PRINT
PRINT #1, " AVERAGE PERCENTAGE ERROR = "; PRR
PRINT
PRINT #1, " STANDARD DEVIATION      = "; SDD
PRINT
PRINT "-------------------------------------------------------"
END
```

```
OPEN "C:\PSK\TAB411.CSV" FOR OUTPUT AS #1
CLS
REM
*************************************************************************
REM *                                                                   *
REM *      THIS PROGRAM CALCULATES THE FLOWRATES THROUGH
                              SURFACE CHOKES  *
REM *                         BY SACHDEVE MODEL                  *
REM *                                                                   *
REM *                         TABLE 4.11                        *
REM
*************************************************************************
FOR I = 1 TO 102
READ BS, QA, PTF, TEMP, RS, GOR,FW
DENO = .78: DENG = .82:   Z1 = .89: K = 1.4
BO = (1 + (.00033 * (TEMP - 60)) / DENO ^ 1.8297) * (1 + .00048 * RS)
BG = 14.7 * (TEMP + 460) * Z1 / (PTF * 520)
DENG1 = DENG * .0765 / BG
DENO = DENO * 62.4
FO = 1 - FW
X1 = DENG1 * (GOR - RS) * .0765 / (DENO * 5.615 + DENG1 * (GOR - RS) *
.0765)
VG1 = DENG1 / BG
YC = (2 / (K + 1)) ^ (K / (K - 1))
REM PRINT YC, X1, VG1, K
DRM2 = X1 / DENG1 + (1 - X1) / DENO
RM2 = 1 / DRM2
REM RM2 = 1 / (X1 * VG1 * YC ^ (-1 / K) + (1 - X1) * VL)
A2 = 3.14 * (BS / (12 * 64)) ^ 2 / 4
VG2 = VG1 * YC ^ (-1 / K)
QO = .75 * A2 * 86400 * SQR(2 * 32.2 * 144 * PTF * RM2 ^ 2 * (((1 - X1) * (1 -
YC) / ((DENO) + X1 * K * (VG1 - YC * VG2)))))
QO = QO / DENO
DIFF = (QA - QO) * 100 / QA
REM PRINT USING "######"; I; PTF; PTFC; DIFF
DIF = DIF + (DIFF / 102) ^ 2
```

```
PRRO = PRRO + DIFF
DIF20 = DIF20 + (DIFF) ^ 2
IF I = 1 OR I = 36 OR I = 71 THEN
PRINT CHR$(12)
PRINT #1, "  TABLE 4.12 SURFACE CHOKE FLOWRATE PREDICTION BY
SACHDEVA MODEL"
PRINT ""
PRINT "-------------------------------------------------------"
PRINT "    TEST NO.      MEASURED      PREDICTED      % ERROR "
PRINT "                  FLOWRATE      FLOWRATE"
PRINT "                  BBLS/D        BBLS/D "
PRINT "-------------------------------------------------------"
PRINT
END IF
PRINT #1, I; ","; QA; ","; QO; ","; DIFF
NEXT I
PRR = PRRO / (I - 1)
SDD = SQR(ABS(DIF20 - I * DIF) / (I - 2))
PRINT "-------------------------------------------------------"
PRINT
PRINT #1, " AVERAGE PERCENTAGE ERROR = "; PRR
PRINT
PRINT #1, " STANDARD DEVIATION      = "; SDD
PRINT
PRINT "-------------------------------------------------------"
END
```

```
OPEN "C:\PSK\TAB412.CSV" FOR OUTPUT AS #1
CLS
REM
*************************************************************************
REM *                                                                   *
REM *     THIS PROGRAM CALCULATES THE FLOWRATES THROUGH
                                    SURFACE CHOKE   *
REM *                               BY PERKINS MODEL                    *
REM *                                                                   *
REM *                                                                   *
REM *                                TABLE 4.12                         *
REM *                                                                   *
REM
*************************************************************************
FOR I = 1 TO 102
READ BS, QA, PTF, TEMP, RS, GOR,FW
DENO = .78: DENG = .82: Z1 = .89: K = 1.4: M = 330: R = 1.98
DENW = 62.4
BO = (1 + (.00033 * (TEMP - 60)) / DENO ^ 1.8297) * (1 + .00048 * RS)
BG = 14.7 * (TEMP + 460) * Z1 / (PTF * 520)
DENA = 141.5 / (DENO - 131.5)
DENG1 = DENG * .0765 / BG
MO = DENO * 62.4 * 5.615
MG = GOR * DENG1
MT = MO + MG
FG = MG / MT
FO = MO / MT
CVG = Z1 * R / (M * (K - 1))
CVO = 778 * ((.355 + .000176 * DENA) + (.0051 + 1.167E-05 * DENA) * TEMP)
NO = ((FG * K * CVG) + (FO + CVO)) / ((FG * CVG) + (FO * CVO))
P2 = PTF * .528
PR = .528
V1 = BO / (DENG * .0765 * RS / 5.615) + BO / (DENO * 62.4)
T2 = (TEMP + 460) * .5 ^ ((NO - 1) / NO)
PM = (PTF + P2) / 2
TM = (TEMP + 460 + T2) / 2
N1 = 1 / NO
N2 = (NO - 1) / NO
N3 = (1 + NO) / NO
ALFA = DENO * ((FO / DENO) + (FW / DENW))
LAMBDA = FG + ((FG * CVG) + (FO * CVO)) * M / (Z1 * R)
```

```
V2 = (1 / PR) ^ N1 * (1 / DENG)
A2 = 3.14 * (BS / (12 * 64)) ^ 2 / 4
A1 = 3.14 * (2.44 / 12) ^ 2 / 4
BV2 = SQR(288 * 32.2 * (LAMBDA * PTF * V1 * (1 - PR ^ ((NO - 1) / NO)) + ((FO
/ DENO) + (FW / DENW) * PTF * (1 - PR))) / (1 - (A2 / A1) ^ 2 * ((FG + ALFA) /
(FG * PR ^ N1 + ALFA)) ^ 2))
QO = .826 * A2 * BV2 * 86400 / (FG * V2 + FW / DENO + FW / DENW) / (DENO *
62.4 * 5.615 + DENG * GOR * .0765)
QO = QO / 5.615
DIFF = (QA - QO) * 100 / QA
REM PRINT USING "######"; I; PTF; PTFC; DIFF
DIF = DIF + (DIFF / 102) ^ 2
PRRO = PRRO + DIFF
DIF20 = DIF20 + (DIFF) ^ 2
IF I = 1 OR I = 36 OR I = 71 THEN
PRINT CHR$(12)
PRINT #1, "  TABLE 4.13 SURFACE CHOKE FLOWRATE PREDICTION BY
PERKINS MODEL"
PRINT ""
PRINT "-------------------------------------------------------------------------"
PRINT "    TEST NO.      MEASURED      PREDICTED     PERCENT "
PRINT "                  FLOWRATE      FLOWRATE      RELATIVE"
PRINT "                  BBLS/D        BBLS/D        ERROR "
PRINT "-------------------------------------------------------------------------"
PRINT
END IF
PRINT #1, I; ","; QA; ","; QO; ","; DIFF
NEXT I
PRR = PRRO / (I - 1)
SDD = SQR(ABS(DIF20 - I * DIF) / (I - 2))
PRINT "-----------------------------------------------------"
PRINT
PRINT #1, " AVERAGE PERCENTAGE ERROR = "; PRR
PRINT
PRINT #1, " STANDARD DEVIATION      = "; SDD
PRINT
PRINT "-----------------------------------------------------"
END
```

```
OPEN "C:\PSK\TAB413.CSV" FOR OUTPUT AS #1
CLS
REM
*************************************************************************
REM *                                                                   *
REM *                                                                   *
REM *   THIS PROGRAM CALCULATES THE FLOWRATES THROUGH
                              SURFACE CHOKES      *
REM *                    BY ASHFORD AND PIERCE MODEL                    *
REM *                                                                   *
REM *                                TABLE 4.13                         *
REM
*************************************************************************

FOR I = 1 TO 102
READ BS, QA, PTF, TEMP, RS, GOR,FW
DENO = .78: DENG = .82:   Z1 = .89: K = 1.4: PC = .546
DENO = DENO * 62.4
BO = (1 + (.00033 * (TEMP - 60)) / DENO ^ 1.8297) * (1 + .00048 * RS)
BG = 14.7 * (TEMP + 460) * Z1 / (PTF * 520)
DENG = .0765 * DENG / BG
FO = 1 - FW
K1 = (K - 1) / K
ALFA = 1 / (BO + FW) ^ .5
BETA1 = (1 / K1) * (TEMP + 460) * Z1 * (GOR - RS) * (1 - PC ^ K1)
BETA11 = (198.6 + (TEMP + 460) * Z1 * (GOR - RS) * PC ^ (-1 / K) / (PTF * 144))
BETA2 = (DENO + .000217 * DENG * RS + FW * DENW)
BETA22 = (DENO + .000217 * DENG * GOR + FW * DENW)
BETA10 = BETA1 * BETA2 / (BETA11 * BETA22)
QO = .456 * (BS / 64) ^ 2 * 3.14 * ALFA * BETA10
DIFF = (QA - QO) * 100 / QA
REM PRINT USING "######"; I; PTF; PTFC; DIFF
DIF = DIF + (DIFF / 102) ^ 2
PRRO = PRRO + DIFF
DIF20 = DIF20 + (DIFF) ^ 2
IF I = 1 OR I = 36 OR I = 71 THEN
PRINT CHR$(12)
PRINT #1, "  TABLE 4.14 SURFACE CHOKE FLOWRATE PREDICTION BY
ASHFORD & PIERCE MODEL"
PRINT ""
PRINT "-------------------------------------------------------------------------"
PRINT "   TEST NO.      MEASURED      PREDICTED     PERCENT  "
PRINT "                 FLOWRATE      FLOWRATE      RELATIVE      "
PRINT "                  BBLS/D        BBLS/D        ERROR  "
PRINT "-------------------------------------------------------------------------"
```

```
PRINT
END IF
PRINT #1, I; ","; QA; ","; QO; ","; DIFF
NEXT I
PRR = PRRO / (I - 1)
SDD = SQR(ABS(DIF20 - I * DIF) / (I - 2))
PRINT "-------------------------------------------------------"
PRINT
PRINT #1, " AVERAGE PERCENTAGE ERROR = "; PRR
PRINT
PRINT #1, " STANDARD DEVIATION      = "; SDD
PRINT
PRINT "-------------------------------------------------------"
END
```