### 8.2 Future recommendations

The presented mathematical model can be used as a numerical tool to optimize the hot air copra drying process. The analysis on copra by the methods of mathematical modelling and simulation can be extended to evaluate the moisture diffusivity of similar porous structures like food items.

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# Appendix A: Publications

1. A.R.L. Mendis, A.D.U.S. Amarasinghe and M. Narayana “Numerical modelling of copra drying” (Journal paper in preperation).
2. A. R. L. Mendis, A. D. U. S. Amarasinghe, and M. Narayana, “Particle modelling for convective drying of copra,” in 2017 Moratuwa Engineering Research Conference (MERCon), 2017, pp. 7–12.
   DOI: 10.1109/MERCon.2017.7980447.
3. A. R. L. Mendis, A. D. U. S. Amarasinghe, and M. Narayana, “Numerical Simulation of the Moisture Diffusion in Copra Drying Process,” in 2016 Moratuwa Engineering Research Conference (MERCon), 2016, pp. 192–197.
   DOI: 10.1109/MERCon.2016.7480138.

# Appendix B: OpenFOAM Solver Code

```
/*---------------------------------------------------------------------------*\
  =========                 |
  \\      /  F ield         | OpenFOAM: The Open Source CFD Toolbox
   \\    /   O peration     |
    \\  /    A nd           | Copyright (C) 2011-2013 OpenFOAM Foundation
     \\/     M anipulation  |
-------------------------------------------------------------------------------
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    along with OpenFOAM.  If not, see <http://www.gnu.org/licenses/>.

Application
    icoFoam

Description
    Transient solver for incompressible, laminar flow of Newtonian fluids.

\*---------------------------------------------------------------------------*/

#include "fvCFD.H"

// * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * //
```

```
int main(int argc, char *argv[])
{
    #include "setRootCase.H"

    #include "createTime.H"
    #include "createMesh.H"
    #include "createFields.H"


    // * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * //

    Info<< "\nStarting time loop\n" << endl;

//scalar I = 0.0001;
dimensionedScalar a
(
"a",
dimensionSet(1,-3,-1,0,0,0,0),
scalar(1)
);
dimensionedScalar d
(
"d",
dimensionSet(0,2,-1,0,0,0,0),
scalar(1)
);
dimensionedScalar t
(
"t",
dimensionSet(1,-1,-3,0,0,0,0),
scalar(1)
);
    while (runTime.loop())
    {
        Info<< "Time = " << runTime.timeName() << nl << endl;
//for liquid water

Mexp=(Mexpa*exp(Mexpb*V))+(Mexpc*exp(Mexpd*V));//(52.52*exp(-0.0001576*V))+(27.45*exp(-0.00002*V));//
```

```
//volScalarField Mt
//      (
//       "Mt",
//        TotalMc
//      );
for (int i=0; i<2; i++)//sqrt(pow((Mt-Mexp),2))>I
{

        fvScalarMatrix WEqn
        (
                fvm::ddt(W)
                -fvm::laplacian(D, W)
        );

        solve(WEqn == -k*(W-0.028)*a/(rhow));//WEqn.solve();
por=1-((1-0.8)*(1-W)/(1-iw));
MC=rhow*W*100/((1-por)*rhos);
TotalMC=(100/(rhos*dvol*(1-porosity)))*fvc::domainIntegrate(rhow*((W*pos(W))+(0*neg(W))));
volScalarField condition
     (
      "condition",
       (TotalMC-Mexp)*pos(TotalMC-Mexp)+(TotalMC-Mexp)*(-1)*neg(TotalMC-Mexp)//sqrt(pow((TotalMC-Mexp),2))
     );
//condition.write();
//Mexp.write();
if (condition>error)
{
i=0;
D=((D+Dmax)*pos(TotalMC-Mexp)/2)+((D+Dmin)*neg(TotalMC-Mexp)/2);
}
else
{
i=1;
//D=D;
}

}
V=V+0.05;
```

```
(
    transportProperties.lookup("dw")
);
dimensionedScalar dv
(
    transportProperties.lookup("dv")
);
dimensionedScalar dvol
(
    transportProperties.lookup("dvol")
);
dimensionedScalar Tt
(
    transportProperties.lookup("Tt")
);
dimensionedScalar da
(
    transportProperties.lookup("da")
);
dimensionedScalar db
(
    transportProperties.lookup("db")
);
dimensionedScalar k
(
    transportProperties.lookup("k")
);
dimensionedScalar DT
(
    transportProperties.lookup("DT")
);
dimensionedScalar Dmax
(
    transportProperties.lookup("Dmax")
);
dimensionedScalar Dmin
(
    transportProperties.lookup("Dmin")
);
 (
     transportProperties.lookup("rhos")
 );
 dimensionedScalar rhog
 (
     transportProperties.lookup("rhog")
 );
 dimensionedScalar porosity
 (
     transportProperties.lookup("porosity")
 );
 dimensionedScalar dw
```

```
dimensionedScalar Dmin
(
    transportProperties.lookup("Dmin")
);
dimensionedScalar cp
(
    transportProperties.lookup("cp")
);
dimensionedScalar Mexpa
(
    transportProperties.lookup("Mexpa")
);
dimensionedScalar Mexpb
(
    transportProperties.lookup("Mexpb")
);
dimensionedScalar Mexpc
(
    transportProperties.lookup("Mexpc")
);
dimensionedScalar Mexpd
(
    transportProperties.lookup("Mexpd")
);
dimensionedScalar iw
(
    transportProperties.lookup("iw")
);
```

```
 Info<< "Reading field W\n" << endl;
 volScalarField W
 (
     IOobject
     (
         "W",
         runTime.timeName(),
         mesh,
         IOobject::MUST_READ,
         IOobject::AUTO_WRITE
     ),
     mesh
 );
 Info<< "Reading field V\n" << endl;
 volScalarField V
 (
     IOobject
     (
         "V",
         runTime.timeName(),
         mesh,
         IOobject::MUST_READ,
         IOobject::AUTO_WRITE
     ),
     mesh
 );
 Info<< "Reading field D\n" << endl;
 volScalarField D
 (
     IOobject
     (
         "D",
         runTime.timeName(),
         mesh,
         IOobject::MUST_READ,
         IOobject::AUTO_WRITE
     ),
```

```
    );
    Info<< "Reading field MC\n" << endl;
    volScalarField MC
    (
        IOobject
        (
            "MC",
            runTime.timeName(),
            mesh,
            IOobject::MUST_READ,
            IOobject::AUTO_WRITE
        ),
        mesh
    );
    Info<< "Reading field TotalMC\n" << endl;
    volScalarField TotalMC
    (
        IOobject
        (
            "TotalMC",
            runTime.timeName(),
            mesh,
            IOobject::MUST_READ,
            IOobject::AUTO_WRITE
        ),
        mesh
    );
    Info<< "Reading field Mexp\n" << endl;
    volScalarField Mexp
    (
        IOobject
        (
            "Mexp",
            runTime.timeName(),
            mesh,
            IOobject::MUST_READ,
            IOobject::AUTO_WRITE
        ),

    mesh
);
Info<< "Reading field error\n" << endl;
volScalarField error
(
    IOobject
    (
        "error",
        runTime.timeName(),
        mesh,
        IOobject::MUST_READ,
        IOobject::AUTO_WRITE
    ),
    mesh
);

Info<< "Reading field por\n" << endl;
volScalarField por
(
    IOobject
    (
        "por",
        runTime.timeName(),
        mesh,
        IOobject::MUST_READ,
        IOobject::AUTO_WRITE
    ),
    mesh
);
```

```
Info<< "Reading field T\n" << endl;
volScalarField T
(
    IOobject
    (
        "T",
        runTime.timeName(),
        mesh,
        IOobject::MUST_READ,
        IOobject::AUTO_WRITE
    ),
    mesh
);
```