**Appendix A**

**Hot Air/Gas Drying (Convection)**

In this case, no radiation is present. Thus corresponding terms in left side of energy balances is set to zero.

While the average moisture content of the paper is greater than its critical moisture content, XC, follow procedure bellow;

1. Set all physical properties equal to their available constant values in literature.
2. From venting air/hot gas speed calculate Reynolds number.
3. Using Re and Pr numbers, calculate Nu number, and from that find the value of h.
4. Find the depth of penetration using modified washburn equation.
5. From value of lambda, each zone thickness is obtained.
6. Solve conservation balances obtained using a numerical method considering coupling of these two equations together, we use ODE45 method in MATLAB which itself uses a fourth-fifth adaptive step size Runge-Kutta.
7. Continue until X equals to XC.

When X is lower than XC, internal diffusion occurs, thus variable properties should be accounted for. So Equations 15-18 should be used for evaluation of physical properties.

1. Evaluate physical properties from obtained correlation.
2. From venting air/hot gas speed calculate Reynolds number.
3. Using Re and Pr numbers, calculate Nu number, and from that find the value of h.
4. Find the depth of penetration using modified washburn equation.
5. From value of lambda, each zone thickness is obtained.
6. For diffusion of vapor to upper zones, using an appropriate relation, calculated the diffusivity, and then evaporation rate to upper zone.
7. Solve conservation balances obtained using a numerical method considering coupling of these two equations together, we use ODE45 method in MATLAB which itself uses a fourth-fifth adaptive step size Runge-Kutta.
8. Stop calculation when X reaches to final product’s desired moisture value, here 0.02.
9. **Radiant Drying (IR)**

In this case, no convection is present. Thus corresponding terms in left side of energy balances is set to zero. Here the effect of distance of heater is to be studied, so equation 6 is used for calculation of shape factor. The procedure is;

While the average moisture content of the paper is greater than its critical moisture content, XC, follow procedure bellow;

1. Set all physical properties equal to their available constant values in literature.
2. From Eq. 6 calculate shape factor for current distance of heater from the web surface.
3. Solve Equations 3 and 4 in each time step in order to find value of Equation 5.
4. Find the depth of penetration using modified Washburn equation.
5. For diffusion of vapor to upper zones, using an appropriate relation, calculated the diffusivity, and then evaporation rate to upper zone.
6. From value of lambda, each zone thickness is obtained.
7. Solve conservation balances obtained using a numerical method considering coupling of these two equations together, we use ODE45 method in MATLAB which itself uses a fourth-fifth adaptive step size Runge-Kutta.
8. Continue until X equals to XC.

When X is lower than XC, internal diffusion occurs, thus variable properties should be accounted for. So Equations 15-18 should be used for evaluation of physical properties. Using same procedure as above, continue calculations till the desired final moisture content, 0.02, reaches.

1. **Mixed IR and Convection**

In this case, mas and energy equations should be solved. Two mentioned procedure in previous section A and B, merged and used together for the distance D and the speed V.

While the average moisture content of the paper is greater than its critical moisture content, XC, follow procedure bellow;

1. Set all physical properties equal to their available constant values in literature.
2. From Eq. 6 calculate shape factor for current distance of heater from the web surface.
3. Solve Equations 3 and 4 in each time step in order to find value of Equation 5.
4. From venting air/hot gas speed calculate Reynolds number.
5. Using Re and Pr numbers, calculate Nu number, and from that find the value of h.
6. Find the depth of penetration using modified Washburn equation.
7. For diffusion of vapor to upper zones, using an appropriate relation, calculated the diffusivity, and then evaporation rate to upper zone.
8. From value of lambda, each zone thickness is obtained.
9. Solve conservation balances obtained using a numerical method considering coupling of these two equations together, we use ODE45 method in MATLAB which itself uses a fourth-fifth adaptive step size Runge-Kutta.
10. Continue until X equals to XC.

The same procedure but with variable physical properties is used for X lower than Xc until the final desired moisture content reaches.