科技文献检索证明

委托要求：要求查找徐野的科技论文被美国《工程索引》(EI Compendex)收录的情况。

委托人：徐野

检索结果：经检索，徐野2013-2014年发表的科技论文有2篇被美国《工程索引》(EI Compendex)收录，检索结果如下：

1. **On a routing method of WSN - in a complex networks view**
   Xu, Ye (College of Information Science and Engineering, Shenyang Ligong University, Shenyang, 110159, China); Jiang, Yueqiu **Source: Sensors and Transducers**, v 162, n 1, p 146-151, 2014
   **Database:** Compendex
   **Accession number:** 20141217498596

2. **Intelligent fault diagnosis of house transformer simulation system in hydro-electricity factory by fuzzy reasoning**
   Xu, Ye (College of Information Science and Engineering, Shenyang Ligong University, Shenyang 110159, China) **Source:** International Journal of Internet Manufacturing and Services, v 3, n 2, p 87-98, 2013
   **Database:** Compendex
   **Accession number:** 20140517255353

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Pages Title and authors

87-98 Intelligent fault diagnosis of house transformer simulation system in hydro-electricity factory by fuzzy reasoning
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165- On a routing method of WSN in manufacturing - a complex networks view
Ye Xu; Yueqiu Jiang
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Intelligent fault diagnosis of house transformer simulation system in hydro-electricity factory by fuzzy reasoning

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Abstract: Fault diagnosis of house transformer in hydro-electrical simulating system (HESS) is studied. Fuzzy reasoning is used in the fault diagnosis due to the uncertainty and complexity in house transformer faults. Fuzzy diagnosis matrix is firstly constructed according to the collection of fault symptoms and the cause set. Fault-cause fuzzy vector, then, is gained after computation between fault symptom fuzzy vector and fuzzy diagnosis matrix. With the maximum membership principle exerted on this fault cause fuzzy vector, fuzzy fault diagnosis is implemented. Real data from a hydro-electric factory is used in experiments proving the efficiency of the fuzzy fault diagnosis method.

Keywords: fault diagnosis; hydro-electricity simulating system; fuzzy set; house transformer.


Biographical notes: Ye Xu received his PhD degree major in Computer Application Technology in 2006 from Noreastern University, China. He is currently working as an Associate Professor in Shenyang Ligong University, China. His current research interests include complex networks and intelligent systems.

1 Introduction

Hydro-electrical simulating system (HESS) is a self-owned intellectual property software system developed for Fengman hydro-electrical factory, Jilin province, China. HESS is composed of five parts, the central control unit, the local operating room, the instructor platform, the computer room, and the interface devices. And the simulating models include the hydro electric generator set, host excitation system, main transformer system, unit relay protection and system, automatic device, and the signal system; as well as the main electrical wiring system, auxiliary power system, and the direct current system. The overall architecture of the simulation support environment is shown in Figure 1.

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A transformer is a device that transfers electrical energy from one alternating circuit to another with a change in voltage, current, phase, or impedance. A power grid comprises many power plants and power consumers who have different requirements for electric voltage. Under such conditions, transformers are the essential parts of a power grid.

House transformer is a kind of important device in a hydro-electrical factory. There are mainly two types of house transformer in Fengman hydro-electrical factory, the high-voltage transformer and the low-voltage transformer. The high-voltage transformer transforms the three-phase electricity by generator sets from 13.8 KV to 3.3 KV, while the low-voltage one transforms the electricity from 3.3 KV to 400 V. Fatal injuries will be caused to the hydro-electrical factory in case of house transformers faults.

The failure rate of the house transformer, however, is 0.085 times per year because of the complexity. Timely and accurately finding fault and making diagnosis are essential guarantees in house transformer troubleshooting (Tian, 2008).

The fault diagnosis system for house transformer, then, is of great value in real hydro-electrical factory or in other HESSSs. In this paper, we first give tests on phenomena and reasons of fault of transformers, then give mathematical depictions of these observed faults. Finally, we use fuzzy reasoning to get a model of fault diagnosis of house transformer after correctness proof by some experiments.
### Table 1: Summary of transformer failure phenomena and reasons

<table>
<thead>
<tr>
<th>Phenomena and reasons</th>
<th>WLSSC</th>
<th>WITSC</th>
<th>WPPSC</th>
<th>PWBD</th>
<th>SWBD</th>
<th>TLO</th>
<th>WIR</th>
<th>IA</th>
<th>TPDRU</th>
<th>GRF</th>
<th>TPR</th>
<th>CMPG</th>
<th>IOO</th>
<th>FD</th>
<th>EY</th>
<th>IOD</th>
<th>WOML</th>
<th>ICLI</th>
<th>TN</th>
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<tbody>
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Notes: WLSSC: winding layer-strand short circuit; WITSC: winding inter-turn short circuit; WPPSC: winding phase-to-phase short-circuit; PWBD: primary winding breakdown or destroy; SWBD: secondary winding breakdown or destroy; TLO: transformer local overheat; WIR: winding insulation resistance; IA: insulation aging; TPDRU: Three-phase DC resistance unbalance; GRF: gas relay frequent; TPR: transformer phase running; CMPG: core multiple point grounding; IOO: insulating oil oxidation; FD: flashover discharge; EV: electromagnetic vibration; IOD: insulation oil deterioration; WOML: winding and oil media loss; ICLI: iron core loss increased; TN: transformer noise.
Table 1  Summary of transformer faults phenomena and reasons (continued)

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<tr>
<th>Phenomena and reasons</th>
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<th>WITSC</th>
<th>WPPSC</th>
<th>SWBD</th>
<th>TLO</th>
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<th>IOO</th>
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<th>EV</th>
<th>IOD</th>
<th>WOML</th>
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<th>TN</th>
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<tr>
<td>Improper operation and maintenance</td>
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Notes: WLSSC: winding layer-strand short circuit; WITSC: winding inter-turn short circuit; WPPSC: winding phase-to-phase short-circuit; PWBD: primary winding breakdown or destroy; SWBD: secondary winding breakdown or destroy; TLO: transformer local overheat; WIR: winding insulation resistance; IA: insulation aging; TPDRU: Three-phase DC resistance unbalance; GRF: gas relay frequent; TPR: transformer phase running; CMPG: core multiple point grounding; IOO: insulating oil oxidation; FD: flashover discharge; EV: electromagnetic vibration; IOD: insulation oil deterioration; WOML: winding and oil media loss; ICLI: iron core loss increased; TN: transformer noise.
2  Fuzzy fault diagnosis of house transformer

2.1  Fault of transformers

2.1.1  Main phenomena and reasons
Transformer abnormal phenomenon usually is visible appearance including abnormal sound, abnormal smell, alarm sound, and severe heat on transformer shell. These phenomena are external response of internal faults, and certainly, are essential factors for fault diagnosis.

There are mainly six types of faults.

- Winding failures
  Winding faults are the faults of transformer’s windings and insulators. The main reasons are aging of insulation, winding moisture, grounding, circuit breakers, a short circuit, and breakdown or destroyed failures of windings.

- Electromagnetic failures
  Electromagnetic failures are mainly caused by iron clamp loose in the core component, vibration and noise caused by loosened iron core, bad grounding or burned out iron core, core sheet insulation aging, irregular holes by core installation error and iron core overheat.

- Structure and attachment failures
  Structure and attachment failures includes local overheat by bad or dislocation of joint contact, explosion-proof failure, gas relay failure or malfunction, radiator, cooling plug or leakage, and so on.

- Oil cooling and cooling media failures
  Oil cooling and cooling media failures are failures of the transformer oil and special cooling media in oil-immersed transformers and all-sealed transformer cabinet. They are mainly caused by decreasing electrical insulation performance due to transformer oil moisture and oxidation, radiator performance deterioration due to sludge deposit and block. For special cooling media transformers, failures will occur when pressure declines for leakage by bad seal.

- Failures caused by defect manufacturing technology and improper repairing methods.

- Failure caused by improper operation and poor maintenance.

Some of typical failures are listed in Table 1.

2.1.2  The way to acquire fault phenomena
Basically, there are two ways to monitor transformer fault phenomena – the offline and online way.

The offline way is to monitor transformer manually and periodically first, and then save the results and compare with history data so as to find the transformer faults. It is a simple way but with many limitations such as incapability of continuous monitors.
On the contrary, the online way is to monitor transformer state in real time by installing sensors in key positions or essential parameter in session of the house transformer. The online way can implement a whole process of monitoring, without any missing out.

The online monitor way is adopted by Fengman hydro-electrical factory and is certainly used as data sources in the simulation system. Table 2 shows the monitor details.

<table>
<thead>
<tr>
<th>No.</th>
<th>Symbols</th>
<th>Parameter name</th>
<th>Abnormal performance</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I</td>
<td>Current</td>
<td>I &gt; I_h (normal)</td>
<td>Overload running</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I ≤ I_h (normal)</td>
<td>External incomplete short circuit</td>
</tr>
<tr>
<td>2</td>
<td>V</td>
<td>Voltage</td>
<td>V &gt; U_h (normal)</td>
<td>Over-voltage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>V ↓</td>
<td>External short circuit</td>
</tr>
<tr>
<td>3</td>
<td>cosφ</td>
<td>Power factor</td>
<td>cosφ ↓</td>
<td>Internal short circuit</td>
</tr>
<tr>
<td>4</td>
<td>P</td>
<td>Active power</td>
<td>P ↓</td>
<td>Iron loss increase</td>
</tr>
<tr>
<td>5</td>
<td>MΩ</td>
<td>Insulation resistance</td>
<td>MΩ ↓</td>
<td>Insulator carbide by insulation aging or moisture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MΩ ↓ → 0MΩ</td>
<td>Break down and short circuit</td>
</tr>
<tr>
<td>6</td>
<td>t</td>
<td>Temperature</td>
<td>t &gt; t_max</td>
<td>Over-current running</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Local heat</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Turn to turn short circuit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>△t↑↑ Break down and incomplete short circuit of discharge winding</td>
</tr>
<tr>
<td>7</td>
<td>Oil</td>
<td>Transformer oil</td>
<td>Breakdown voltage less than 42 kV</td>
<td>Moisture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Insulation aging</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Internal discharge oil carbide</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Oil vapourisation</td>
</tr>
<tr>
<td>8</td>
<td>Gas</td>
<td>Air</td>
<td>Gas-actuated relay</td>
<td>ARC discharge oil vapourisation</td>
</tr>
<tr>
<td>9</td>
<td>a</td>
<td>Vibration</td>
<td>Iron core loose</td>
<td>Iron core loose</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Continue to discharge</td>
<td>Over-current running</td>
</tr>
<tr>
<td>10</td>
<td>CH</td>
<td>Ultrasonic sound</td>
<td>Discontinuous noise (light)</td>
<td>Internal discontinuous discharge</td>
</tr>
<tr>
<td>11</td>
<td>H₂</td>
<td>H</td>
<td>Hydrogen content Increase</td>
<td>Internal local electric generation and discharge</td>
</tr>
<tr>
<td>12</td>
<td>F₂, W₄</td>
<td>Cooling media (fan and water)</td>
<td>Cut off or power failure</td>
<td>Transformer temperature increase</td>
</tr>
</tbody>
</table>
2.2 Membership functions of fault phenomenon and fault reason of house transformer

When setting up membership functions, the theory domain of a fuzzy set should be firstly determined. A selected theory domain will help reduce the complexity and workload. The domain elements for theory domains with membership grades to 1, 0, and 0.5, respectively, are determined as follows (Deschrijver and Kerre, 2003; Xiong et al., 2012; Chiclana et al., 2001; Hu et al., 2011).

1 Domain element collection of membership to 1

If elements definitely belong to a certain fuzzy set, then the membership grade of these elements can be assigned the value 1. The principal value interval size directly effects the shape of the membership function curve in top.

2 Domain element collection of membership to 0

If elements definitely do not belong to a certain fuzzy set, then the membership grade of these elements can be assigned the value 0. Transition zone of the membership function curve is determined by domain element collection of membership grade from 1 to 0.

3 Domain element collection of membership to 0.5

If it is hard to determine whether elements belong to a certain fuzzy set or not, then the membership grade of these elements can be assigned the value 0.5. These domain elements produce the most fuzzy point in the membership function curve.

According to various influencing factors of the house transformer, together with expert experiences, membership functions of each influencing factor is determined as below.

- membership function of ‘too large current’

\[
\mu_A(x) = \begin{cases} 
0 & x \leq b \\
\frac{1}{2} \left( \frac{x - b}{a - b} \right)^2 & b < x < \frac{a + b}{2} \\
\frac{1}{2} - \frac{1}{2} \left( \frac{x - a}{a - b} \right)^2 & \frac{a + b}{2} \leq x \leq a \\
1 & x \geq a 
\end{cases}
\]  

(1)

where \(a = 200(A), b = 50(A)\)

- membership function of ‘too small voltage’

\[
\mu_A(x) = \begin{cases} 
1 & x \leq a \\
\frac{1}{2} \left( \frac{x - a}{b - a} \right)^2 & a \leq x < \frac{a + b}{2} \\
\frac{1}{2} - \frac{1}{2} \left( \frac{x - b}{b - a} \right)^2 & \frac{a + b}{2} \leq x \leq b \\
0 & x > b 
\end{cases}
\]  

(2)

where \(a = 100(V), b = 3,300(V)\)
• membership function of ‘too small active power’

\[
\mu_a(x) = \begin{cases} 
1 & x \leq a \\
1 - 2 \left( \frac{x-a}{b-a} \right)^2 & a \leq x < \frac{a+b}{2} \\
2 \left( \frac{x-b}{b-a} \right)^2 & \frac{a+b}{2} \leq x \leq b \\
0 & x > b 
\end{cases}
\]  

where \(a = 33\text{(KW)}, \ b = 330\text{(KW)}\)

• membership function of ‘too small insulation resistance’

\[
\mu_a(x) = \begin{cases} 
1 & x \leq a \\
1 - 2 \left( \frac{x-a}{b-a} \right)^2 & a \leq x < \frac{a+b}{2} \\
2 \left( \frac{x-b}{b-a} \right)^2 & \frac{a+b}{2} \leq x \leq b \\
0 & x > b 
\end{cases}
\]  

where \(a = 10\text{(KΩ)}, \ b = 300\text{(KΩ)}\)

• membership function of ‘too high local temperature’

\[
\mu_a(x) = \begin{cases} 
0 & x \leq b \\
2 \left( \frac{x-b}{a-b} \right)^2 & b < x < \frac{a+b}{2} \\
1 - 2 \left( \frac{x-a}{a-b} \right)^2 & \frac{a+b}{2} \leq x \leq a \\
1 & x \geq a 
\end{cases}
\]  

where \(a = 100\text{(°C)}, \ b = 20\text{(°C)}\)

• Membership function of ‘transformer oil deterioration’

\[
\mu_a(x) = \begin{cases} 
0 & x \leq b \\
2 \left( \frac{x-b}{a-b} \right)^2 & b < x < \frac{a+b}{2} \\
1 - 2 \left( \frac{x-a}{a-b} \right)^2 & \frac{a+b}{2} \leq x \leq a \\
1 & x \geq a 
\end{cases}
\]  

where \(a = 20\%, \ b = 1\%\).
2.3 Fault diagnosis matrix of house transformer

Take ‘winding inter-turn short circuit fault’ for example, the fuzzy reference rules below (Table 3) can be used to represent relationship between the fault phenomenon and the fault reason (Xu, 2004; Huang et al., 2012; Jian et al., 2012; de la Mata and Rodriguez, 2011; Maurya et al., 2010).

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Fuzzy inference rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF (seal aging or seal improperly, 0.9) THEN over current 0.3</td>
<td></td>
</tr>
<tr>
<td>IF (seal aging or seal improperly, 0.7) THEN transformer oil deterioration 0.9</td>
<td></td>
</tr>
<tr>
<td>IF (overvoltage by lightning or false operations, 0.2) THEN too large current 0.9</td>
<td></td>
</tr>
<tr>
<td>IF (overvoltage by lightning or false operations, 0.4) THEN voltage drop quickly 0.3</td>
<td></td>
</tr>
<tr>
<td>IF (overvoltage by lightning or false operations, 0.7) THEN active power drop quickly 0.9</td>
<td></td>
</tr>
<tr>
<td>IF (overvoltage by lightning or false operations, 0.9) THEN insulation resistance drop quickly 0.9</td>
<td></td>
</tr>
<tr>
<td>IF (transformer overrunning, 0.6) THEN too large current 0.3</td>
<td></td>
</tr>
<tr>
<td>IF (transformer overrunning, 1) THEN voltage drop quickly 0.3</td>
<td></td>
</tr>
<tr>
<td>IF (transformer overrunning, 0.8) THEN too high local temperature 0.9</td>
<td></td>
</tr>
<tr>
<td>IF (wire poor quality, 0.6) THEN too high local temperature 0.6</td>
<td></td>
</tr>
<tr>
<td>IF (wire poor quality, 0.7) THEN transformer oil deterioration 0.3</td>
<td></td>
</tr>
<tr>
<td>IF (fuel tank leakage, 0.8) THEN too large current 0.3</td>
<td></td>
</tr>
<tr>
<td>IF (fuel tank leakage, 0.9) THEN insulation resistance drop quickly 0.3</td>
<td></td>
</tr>
<tr>
<td>IF (fuel tank leakage, 0.7) THEN transformer partial overheat 0.6</td>
<td></td>
</tr>
<tr>
<td>IF (external short circuit, 0.8) THEN too large current 0.3</td>
<td></td>
</tr>
<tr>
<td>IF (external short circuit, 0.8) THEN too small voltage 0.3</td>
<td></td>
</tr>
<tr>
<td>IF (external short circuit, 0.8) THEN active power drop quickly 0.3</td>
<td></td>
</tr>
</tbody>
</table>

Notes: The values are set according to field expert experiences. 0.9 means a close relationship between the phenomenon and the reason, 0.6 means that relationship exists, 0.3, however, means there is little relationship, and 0 means no relationship.

From principles above, relationship between the fault phenomenon and the fault reason can be gained as Table 4.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Relationship between phenomenon and reason of the ‘winding inter-turn short circuit fault’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fault phenomenon and fault reason</td>
<td>TLC</td>
</tr>
<tr>
<td>Seal aging or seal improperly (F1)</td>
<td>0.3</td>
</tr>
<tr>
<td>Overvoltage by lightning or false operations (F2)</td>
<td>0.9</td>
</tr>
<tr>
<td>Transformer overrunning (F3)</td>
<td></td>
</tr>
<tr>
<td>Wire poor quality (F4)</td>
<td></td>
</tr>
<tr>
<td>Fuel tank leakage (F5)</td>
<td>0.3</td>
</tr>
<tr>
<td>External short circuit (F6)</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Notes: TLC: too large current; TSV: too small voltage; APDQ: active power drop quickly; IRDQ: insulation resistance drop quickly; LOH: local over heat; TOD: transformer oil deterioration.
According to Table 4, the fault diagnosis matrix can be yielded as below.

\[
R = \begin{bmatrix}
0.3 & 0.9 & 0.3 & 0 & 0.3 & 0.3 \\
0 & 0.3 & 0.3 & 0 & 0 & 0.3 \\
0 & 0.9 & 0 & 0 & 0 & 0.3 \\
0 & 0.9 & 0 & 0 & 0.3 & 0 \\
0 & 0 & 0.9 & 0.6 & 0.6 & 0 \\
0.9 & 0 & 0 & 0.3 & 0 & 0
\end{bmatrix}
\]  

(7)

2.4 Fuzzy fault diagnosis of the house transformer

Given a monitored fault shown in Table 5, the fuzzy fault diagnosis process is listed below.

<table>
<thead>
<tr>
<th>Phenomenon</th>
<th>I (A)</th>
<th>U (V)</th>
<th>P (kW)</th>
<th>R (Ω)</th>
<th>T (°C)</th>
<th>Oil (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>1250.15</td>
<td>1102.6</td>
<td>30.53</td>
<td>1135.07</td>
<td>22.4</td>
<td>9.3</td>
</tr>
</tbody>
</table>

According to equations (1) to (6), the membership grades are:

\[
A_I(1250.15) = 1 \\
A_U(1102.6) = 0.81 \\
A_P(30.53) = 0.99 \\
A_R(1135.07) = 1 \\
A_T(22.4) = 0.0018 \\
A_{oil}(0.09) = 0.64
\]

Then, the fault phenomenon vector is:

\[
X = [1 \ 0.81 \ 0.99 \ 1 \ 0.0018 \ 0.64].
\]  

(8)

Multiply the fault phenomenon vector to the fault diagnosis matrix (equation 7), we have:

\[
Y = X \circ R
\]

\[
= \begin{bmatrix}
1 & 0.81 & 0.99 & 1 & 0.0018 & 0.64
\end{bmatrix} \begin{bmatrix}
0.3 & 0.9 & 0.3 & 0 & 0.3 & 0.3 \\
0 & 0.3 & 0.3 & 0 & 0 & 0.3 \\
0 & 0.9 & 0 & 0 & 0 & 0.3 \\
0 & 0.9 & 0 & 0.3 & 0 & 0 \\
0 & 0 & 0.9 & 0.6 & 0.6 & 0 \\
0.9 & 0 & 0 & 0.3 & 0 & 0
\end{bmatrix}
\]

(9)

\[
= \begin{bmatrix}
0.873 & 1 & 0.54 & 0.192 & 0.6 & 0.84
\end{bmatrix}
\]

With equation (9), we can infer the following conclusions,

- fault confidence in F1 is 0.873
- fault confidence in F2 is 1
Intelligent fault diagnosis of house transformer simulation system

- fault confidence in F3 is 0.54
- fault confidence in F4 is 0.192
- fault confidence in F5 is 0.6
- fault confidence in F6 is 0.84.

Failure F2 is sure to be the fault reason according to the maximum membership principle, i.e., the fault of ‘over-voltage by lightning or false operations’ occurred.

3 Overall experiments and performance evaluations of the fuzzy fault diagnosis

Similar to the fault diagnosis of “over-voltage by lightning or false operations fault”, the fuzzy fault diagnosis method is used in some other experiments, and the results are shown in Table 6.

<table>
<thead>
<tr>
<th>Fault</th>
<th>Sample size</th>
<th>Correct</th>
<th>Wrong</th>
<th>Accuracy rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winding layer – strand short circuit</td>
<td>37</td>
<td>21</td>
<td>16</td>
<td>56.7%</td>
</tr>
<tr>
<td>Winding inter – turn short circuit</td>
<td>66</td>
<td>54</td>
<td>12</td>
<td>81.2%</td>
</tr>
<tr>
<td>Winding phase to phase short circuit</td>
<td>103</td>
<td>59</td>
<td>44</td>
<td>57.3%</td>
</tr>
<tr>
<td>Primary winding breakdown or destroyed</td>
<td>70</td>
<td>44</td>
<td>26</td>
<td>62.9%</td>
</tr>
<tr>
<td>Transformer partial overheat</td>
<td>286</td>
<td>243</td>
<td>43</td>
<td>84.5%</td>
</tr>
<tr>
<td>Low winding insulation resistance</td>
<td>52</td>
<td>41</td>
<td>11</td>
<td>78.9%</td>
</tr>
</tbody>
</table>

From Table 6, we find that the lowest accuracy rate is 56.7%, while the highest is 84.5%, and the average is 70.25%. Though the accuracy rate is not that good, the fuzzy fault diagnosis, however, is considered to be acceptable since a rate over 70% is good for the complex hydro-electrical transformers.

4 Conclusions

A fuzzy way of fault diagnosis of house transformer in a hydro-electricity simulating system is studied in this paper. First, the complexity and fuzziness of fault phenomenon and fault reason of house transformers are studied. Fuzzy theory is introduced into solving problems and technologies of fuzzy vectors and fuzz matrix are studied. Second, various fault types of transformers are summarised. As many as six categories of 19 fault phenomena together with 31 fault reasons are classified. Membership grades and membership functions are assigned to corresponding fault phenomena and reasons according to expert experiences. Finally, a fuzzy fault diagnosis model based on fuzzy reasoning is given and experiments prove that it’s acceptable to use the fuzzy reasoning in fault diagnosis of house transformers.
References